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Capacity Remuneration Mechanisms in Energy-Only Markets

In Pursuit of Creating a Regulatory Framework for the Integration of Capacity Remuneration Mechanisms in the European Union Electricity Markets

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CAPACITY REMUNERATION MECHANISMS IN ENERGY-ONLY MARKETS: IN PURSUIT OF CREATING A REGULATORY FRAMEWORK FOR THE INTEGRATION OF CAPACITY REMUNERATION MECHANISMS IN THE EUROPEAN UNION ELECTRICITY MARKETS

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ABSTRACT

Liberalisation of electricity markets in Europe produces challenges for ensuring generation adequacy. There are rising concerns in Europe concerning the competence of energy-only markets to provide generation adequacy in the European Union Electricity Markets. Consequently, many Member States in the European Union including the UK, Germany, France, Italy, Belgium, Poland, Denmark, Spain, Portugal, Greece, Croatia, Sweden and Ireland have introduced or are contemplating the introduction of Capacity Remuneration Mechanisms in their jurisdictions with a unilateral approach. It is known, however, that fragmented and uncoordinated Capacity Remuneration Mechanisms in integrated electricity markets, as in Europe, might cause inefficiencies and distort cross-border trade. These developments raise the controversial issue of creating a regulatory framework to integrate Capacity Remuneration Mechanisms in Europe. This thesis is mainly a research on how this regulatory framework can be established.

With this understanding, throughout the thesis, one research question is asked and tried to be answered: What regulatory framework is required to ensure generation adequacy in energy-only markets, and to integrate unilaterally established Capacity Remuneration Mechanisms in the EU in compliance with the spirit of the Internal Electricity Market?

Answering the first part of research question provides this thesis with a Conceptual Framework. This Conceptual Framework is used to understand the main causes and working principles of Capacity Remuneration Mechanisms. Also, it enables to make a comparison between the theoretical backgrounds of Capacity Remuneration Mechanisms and their reflections in the European Union. To reveal this Conceptual Framework, an extensive literature review is made and, hence, what are the main causes of Capacity Remuneration Mechanisms in energy-only markets are put forward from a theoretical point of view. Accordingly, the missing money problem, the increasing share of intermittent RESs, investment (boom-and-bust) cycle problem and lack of adequate forward contracts are evaluated as main causes of Capacity Remuneration Mechanisms. This theoretical conclusion is supported by analyzing several real-world experiences from the United States to South America. Then, as indicated above, these deductions

derived from the Conceptual Framework are tested within the context of the European Capacity Remuneration Mechanisms established in recent years. Consequently, the main causes of the European Capacity Remuneration Mechanisms are compared with what the Conceptual Framework is provided. It is revealed that although the underlying reasons of Capacity Remuneration Mechanisms in the European Union are mostly same with what the Conceptual Framework provides, there are several reasons unique to the European Union Member States. These reasons are called as "European-centric reasons" in this thesis and ordered as follow: (1) Low Carbon Prices – Failure of the Emission Trading Scheme, (2) Phasing out nuclear and coal power plants, (3) Flood of cheap shale gas: Increasing competitiveness of coal power plants, (4) The Global Financial Crisis 2008.

Having presented the above, all in all, integration of European Capacity Remuneration Mechanisms is asserted as an inevitable necessity. The said integration is defined as accepting foreign capacity resources (i.e. allowing cross-border participation where physically possible) to national Capacity Remuneration Mechanisms within the context of this thesis. Justifications for this integration are put forward from both legal and economic perspectives. Consequently, the thesis proposes some minimum regulatory requirements to harmonize, and thus integrate, national Capacity Remuneration Mechanisms in Europe. These regulatory requirements include the following (not ranked by priority): Harmonized Generation Adequacy Assessments, Respecting Contracted Capacity Obligations, Allocation of Interconnectors' Capacity and No Double Counting. Initiated by the European Commission in 2015, the Energy Union Strategy offers one of the most important opportunities, if not the only opportunity, to meet these requirements. It is understood that the Fourth Energy Package to be brought by the Energy Union Strategy, along with other innovations it will bring, will include the necessary legal framework that enable these minimum regulatory requirements. In this sense, it can be guessed that significant amendments will be made especially to the Electricity Directive and the Security of Electricity Directive. The questions of whether these amendments will be adequate for integrating European Capacity Remuneration Mechanisms; and, thus, whether the challenges caused by these mechanisms can be overcome will be the subject of interesting and important research in next years.

ACKNOWLEDGEMENTS

I had known that it would be a long journey when I started my PhD. But in fact, I could not imagine that it would take such a long time. The fact that the subject of the thesis emerged today is totally different from the subject that I had studied during the first year of my PhD journey makes me quite laugh right now. It must be around March 2013, the date when I decided to write my thesis on Capacity Remuneration Mechanisms. During the previous 11 months, my research had centred upon the relationship between the relevant market analysis of the European Union Competition Law and energy markets. Following the decision to change my research area, my previous studies had been simply and suddenly seemed as a waste of time. Despite this fact, I could not ignore to focus my research on the Capacity Remuneration Mechanisms having started to increase by leaps and bounds in Europe and seemed as a factor giving the European Single Energy Market Policy a deep shock. At the beginning of my studies on this issue, there was a great lack of European specific literature on Capacity Remuneration Mechanisms. The attitude of relevant parties, including the European Commission, on the Capacity Remuneration Mechanisms was largely unclear. I can easily say that my thesis has matured at the very heart of the discussions on Capacity Remuneration Mechanisms in Europe. Of course, there is more to be written on this subject. There are a lot of sources to look at, there are many problems that will be resolved. But I am proud that I have been looking for answers to one of the problems created by Capacity Remuneration Mechanisms during the time I wrote this thesis and that I could finally come up with a particular perspective on the solution of this problem.

Of course, I did not get this pride on my own. In a long, complicated and tiring way like a PhD study, people need support more than ever. Thank goodness, I know I'm lucky in this. I owe all the people who make me feel lucky.

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Özgü Deniz Şahin… My dear wife, my love, my hope and meaning of my life. My wordrobe is not rich enough to express her meaning for me. I can just say that this thesis could not be written without her. Thank you for everything, for every single moment we have spent together.

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DECLARATION

I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Dundee or any other institution.

I can confirm that this dissertation was edited for conventions of language, spelling and grammar by Dr. Geoffrey Wood.

Signed: Taner Şahin
Printed: Taner Şahin
Date: 04.05.2018

SIGNED STATEMENT BY SUPERVISOR

I, the supervisor, hereby acknowledge that the conditions of the relevant Ordinance and Regulations have been fulfilled.

Signed:
Printed:
Date:

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ABBREVIATIONS

APEC	Asia-Pacific Economic Cooperation
ACER	Agency for the Cooperation of Energy Regulators
CREG	Colombian Regulatory Authority
CRM(s)	Capacity Remuneration Mechanism(s)
DECC	Department of Energy & Climate Change
EC	European Commission
ECSC	European Coal and Steel Community
EEC	European Economic Community
EIA	The United States Energy Information Administration
ELIA	The Belgium Transmission System Operator
ENTSO-E	European Network of Transmission System Operators for Electricity
ENERGITILSYNET	The Danish Energy Regulatory Authority
ETS	Emission Trading Scheme
EU	European Union
EUR	Euro
EURATOM	European Atomic Energy Community
EUS	Energy Union Strategy
FCM	Forward Capacity Market
FERC	Federal Energy Regulatory Commission
FRC	Firm Energy Certificate
FRM	Flexibility Remuneration Mechanism
GB	Great Britain
GDP	Gross Domestic Product
GW	Gigawat
ICAP	Installed Capacity
IEA	International Energy Agency
IEEFA	Institute for Energy Economics and Financial Analysis
IEM	Internal Energy Market
IMO	Independent Market Operator (Western Australia)
I-SEM	Integrated-Single Electricity Market
ISO	Independent System Operator
ITO	Independent Transmission Operator
LNG	Liquefied Natural Gas
LOLE	Loss of Load Expectation
LOLP	Loss of Load Probability
LSE	Load Serving Entities

MISO	Midwest Independent Transmission System Operator
MRCP	Maximum Reserve Capacity Price
MW	Megawatt
NATO	North Atlantic Treaty Organization
NBER	National Bureau of Economic Research
NERC	North American Electric Reliability Corporation
NYISO	New York Independent System Operator
OCGT	Open Cycle Gas Turbine
OECD	Organisation for Economic Co-operation and Development
OFGEM	Office of Gas and Electricity Markets
ONS	(Brazil) Operator of the National Electricity System
PJM	Pennsylvania-Jersey-Maryland
PKEE	The Polish Electricity Association
PPAs	Power Purchase Agreements
PV	Photovoltaics
RCM	Reserve Capacity Mechanism
REC(s)	Renewable Energy Certificate(s)
RESs	Renewable Energy Sources
RPM	Reliability Pricing Model
Rte	The French Transmission System Operator
SEA	Single European Act
SO(s)	System Operator(s)
TERNA	The Italian Transmission System Operator
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union
TPA	Third Party Access
TSO(s)	Transmission System Operator(s)
UCAP	Unforced Capacity
UK	United Kingdom
UNDP	United Nations Development Programme
US	United States
VOLL	Value of Lost Load
WEC	World Energy Council
WEM	(Western Australia) Wholesale Electricity Market
WEO	World Energy Outlook
WW2	World War 2

CHAPTER 1 - INTRODUCTION

1. Introduction

Electricity as a non-storable good is vital for welfare objectives and economic activities and lack of power is assumed as enormously costly, disruptive and intolerable in the modern world.[1] The vitality of a reliable electricity supply has arisen from it being indispensable for almost all production of our daily life whether in houses or firms.[2] In this age, from the simplest day-to-day routine operations such as cake making or doing the laundry to the most critical operations such as international financial transactions, public safety or hospital services, the reliable supply of electricity has a critical role. Thus, it is a crucial indicator for the level of development of a country. It can be said that the more countries develop, the more electricity they use, or vice versa. In this regard, Niu et al. mentioned several reasons that show why there is a direct relationship between the development level of a country and its electricity consumption: (1) Access to electricity contributes to human health by allowing food, vaccines and medicines to be stored for longer periods; (2) Lighting increases the literacy rate in adult citizens as people will have the opportunity to study longer. In addition, computer, television and internet facilities make it easier for people to access information; (3) Access to electricity makes it possible to use many household appliances that improve the quality of life, such as heating, cooling, sanitation, and entertainment; (4) Electricity can be produced from clean sources such as wind, sun, nuclear, biomass and hydro with significantly reduced carbon emission; (5) Access to electricity offers opportunities for women especially in rural areas to saving much time for their self-employment

[1] CEPEDA M. and FINON D., 'Generation Capacity adequacy in interdependent electricity markets', 39 *Energy Policy* (2011), pp.3128-3143, p. 3128.

[2] M. Nooij *et al* evaluates the significance of security of supply by taking into account the value of power-supply in our daily-life using a production-function approach. In this article, the welfare-lost effect of potential power-supply interruption is estimated for different sectors and timeframes. For further discussion: *See*, NOOIJ M. *et al,* 'The value of supply security, the costs of power interruption: Economic input for damage reduction and investment in networks', 29 *Energy Economics* (2007), pp.277-295.

and other potential development.[3] For these reasons, electricity is a crucial element of all commercial, industrial and governmental activities and is essential for producing all goods and services.

Electricity is, in this sense, the most basic source of life for a modern economy. It can be said that what oxygen and water mean for the life of a person or animal or plant, electricity is the same for a modern economy to survive in a healthy way. When evaluating the devastating outcomes of possible shortage of electricity, it can be understood that this is not an exaggeration. For instance, the case of California in the early 2000s showed how the social costs of any electricity supply crisis can be high. On this issue, De Vries and Hakvoort provided some dramatic statistics:

> "The outages in California totalled 30 hours, spread over six days. The largest amount of electricity not served at any given time was 1000 MW, although much of the time the outages affected a much smaller volume of load. To place these figures in perspective: during 0.3% of the year, a maximum of 2% of electricity demand was not served. Despite the seemingly small proportion of time that there actually were outages, the estimated social costs of the crisis are 45 billion USD."[4]

In addition to the electricity crisis in California between 2000 and 2001, problems stemming from electricity supply blackouts experienced across the world in the first decade of the 2000s can be shown as other examples of the damaging effects of a possible shortage of generation capacity in the electricity industry. In light of these discussions, it can be said that the reliable supply of electricity, or in general, energy security, is one of the most critical issues for modern life.

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[3] NIU S. et al., 'Electricity consumption and human development level: A comparative analysis based on panel data for 50 countries', (2013), 53 *International Journal of Electrical Power and Energy Systems*, pp. 338-347.

[4] DE VRIES L.J. and HAKVOORT R.A., 'The question of generation adequacy in liberalised electricity markets', <https://www.ecn.nl/fileadmin/ecn/units/bs/INDES/indes-ldv_paper.pdf>, accessed 19.10.2017.

2. What Makes Electricity Unique?

Electricity may initially appear to be a normal commodity, which most probably opened its way to liberalisation and deregulation, but in many respects it is a different kind of product.[5] These differences have fundamentally affected the structure of electricity markets stretching back decades in the past. However, even after liberalisation, the structure of electricity markets is still mostly determined by the following idiosyncratic features of electricity. According to Hunt, there are four technical truths about electricity which make it different from other commodities: (1) Electricity cannot be economically stored; (2) Electricity travels at the speed of light; (3) Electricity travels on less resistant lines; and (4) Because the electricity industry is structured as a network-bound system including transmission and distribution lines, any incident that is experienced at any point on a transmission line affects conditions on the electricity system many kilometers away.[6]

These distinctive features of electricity make electricity markets unique compared to other markets. Of course, electricity can be stored with the help of different battery or other forms of storage technologies. It is also understood that rapid developments in battery technology show that in the future storage problems for electricity will possibly become a reduced problem. However, as noted by Laloux and Rivier, "[…] at present, electricity must be generated and transmitted as it is consumed, which means that electric systems are dynamic and highly complex, as well as immense. At any given time, these vast dynamic systems must strike a balance between generation and demand […]."[7]

Due to these characteristics of electricity, reliability inevitably becomes extremely complicated in electricity markets. As discussed further in Chapter 2, reliability of electricity supply must be organised for different time periods from the short to long term. Nevertheless, as the short-term

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[5] LALOUX D. and RIVIER M., 'Technology and Operation of Electric Power Systems', Chapter 1 in I. J. PEREZ-ARRIAGA (Ed.), *Regulation of the Power Sector,* Springer, London,2013, p.2.

[6] HUNT S., *Making Competition Work in Electricity Markets,* John Wiley & Sons, New York, 2002, pp.30-32.

[7] LALOUX D. and RIVIER M., 'Technology and Operation of Electric Power Systems,' *Supra* note 5, p.2

is extremely short and the long term is considerably long, a lack of supply at any time in a day can be very costly; however, what is more crucial is that building new capacity to overcome these costly blackouts can take many years.[8] Furthermore, there are huge ambiguities for both demand and supply side that lead to complicating challenges to balance supply and demand.[9] These difficulties can be ordered as below:[10]

1- Electricity demand is hugely inelastic. Although in theory consumers should respond to market prices on a sudden or short-term basis, they rarely have the information to do so. Reliability of electricity supply concerns generally arise from this lack of demand side problem. It can be expected that increasing low carbon electricity generation will make this challenge more intractable.
2- The electricity industry is a network-bound market. Reliability of electricity supply does not only depend upon generation adequacy as enough transmission and distribution lines are also critical.
3- Storing electricity is very limited, if not zero. Hence, some excess capacity is essential for the reliability of electricity supply, and in a free market economy there should be market-supporting incentives to build such facilities.
4- Investment for electricity generation inherently faces the diversification challenge. The reason for this is that unless there are incentives or interventions from government, investors by their nature go towards less costly generation investments, which pose risks regarding diversification.
5- The last reason for this is that incrementally increasing demand for electricity and, thus, raising the requirement for new generation investments do not always go in the same

[8] CRAMTON P. and OCKENFELS A., ‘Economics and design of capacity markets for the power sector’, 30.05.2011, <http://www.cramton.umd.edu/papers2010-2014/cramton-ockenfels-economics-and-design-of-capacity-markets.pdf> accessed 29.03.2013.
[9] *ibid.*
[10] KEAY M., ‘Can the Market Deliver Security and Environmental Protection in Electricity Generation?’, in RUTLEDGE I. and WRIGHT P. (eds), *UK Energy Policy and the End of Market Fundamentals*, The Oxford Institute for Energy Studies, The Oxford University Press, 2010, p.286-289, pp.281-308.

direction as environmental concerns. This dilemma constitutes one of the most critical challenges for energy policies.

To cope with these difficulties, many electricity markets have been established with short-term (hourly) and medium-term (1-4 years) forward markets, which are either controlled on a central basis or improved directly by market mechanism.[11] However, unless there is adequate capacity in the long term, it will not be likely to manage either the short-term or medium-term reliability of electricity supply. Long-term generation adequacy, hence, can be seen as one of the most critical issues for reliability of electricity supply concerns. At this juncture, the peril point is thus: who is responsible for long-term generation adequacy? The answer to this question has changed throughout history. In the past, governments completely owned and controlled electricity (and gas) industries.[12] These industries operated in line with the direction of government regulators in countries such as the United States (US) and Germany where facilities are normally privately owned.[13] So, at the beginning, that is, before liberalisation, governments were the sole responsible authority for ensuring generation adequacy. This responsibility started to shift to market participants following liberalisation of electricity markets. However, several imperfections in energy-only markets and some unwelcome cases such as California have pushed governments to take more responsibility in ensuring reliability, or more specifically, generation adequacy by means of establishing Capacity Remuneration Mechanisms (CRMs). It can be said that the current role of governments in ensuring generation adequacy does not mean returning back to the past; rather, it can be seen as a new step in the liberalisation process.

3. Liberalisation[14] in Electricity Markets

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[11] CRAMTON P. and OCKENFELS A., 'Economics and design of capacity markets for the power sector', *Supra note* 8.

[12] DOW S., 'Unit 1: Energy Policy and Energy Strategy', Unpublished Lecture Notes for Downstream Energy Law and Policy, University of Dundee, CEPMLP, p.4.

[13] *ibid.*

[14] Everyone who writes about reforms in the electricity market speaks about certain concepts. These concepts are as follows. For terminological clarification, some definitions regarding these concepts should be made. The terms liberalisation, privatisation, deregulation and restructuring are different concepts but are generally all employed in the same context. At its core, liberalisation can be described

3.1 Liberalisation in Electricity Markets

A well-known Latin proverb states “nihil novi sub sole”, meaning “there is nothing new under the sun.” It is obvious that this proverb means that everything that can be experienced has already been experienced in this world, so something new can no longer be found. In other words, history repeats itself. With this understanding, it is certain that nearly everything to be written about liberalisation in the context of electricity markets have already been written from different perspectives. However, this fact does not change another fact that understanding the dynamics

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as “the removal of a monopoly right and the introduction of competition and choice”. Liberalisation can be realised either fully or partially. In other words, while all segments of the market may be opened to competition in full liberalisation, only some parts of market may be opened to competition in partial liberalisation. Most of the time, liberalisation of electricity and gas industries can be given as examples of the latter type of liberalisation. Privatisation is in short a decision and action of selling state companies to a third party. The other concept, deregulation, is about a process that reduces/removes regulation from certain segments of electricity markets. Like many other concepts of social sciences, there is no commonly accepted definition of regulation. According to IEA, regulation is a policy instrument used for price and volume controls, imposing market regulations (through entry/exit decisions, monopoly rights and anti-cartel legislation), introducing environmental and technical regulations. Posner defined economic regulation as a form of government intervention including all sorts of taxes and subsidies as well as other legislative and administrative controls over economic activities. According to Stigler, regulation is a tool to serve industry through being acquired by it. Levi-Faur defined regulation as “the promulgation of prescriptive rules as well as the monitoring and enforcement of these rules by social, business, and political actors on other social, business, and political actors.” In accordance with these definitions, it could be argued that regulation can be defined as a governmental tool used for controlling economic activities of market players. So, in this sense, deregulation is to eliminate controls on prices and entry of new competitors. The last concept abovementioned is restructuring. It means changing the structure of existing companies; that is, splitting existing companies into separate segments and/or combining some segments of these companies. *See* DOW S., ‘Unite 1: Energy Policy and Energy Strategy’, *Supra* note 12, p.6-16; IEA, *The role of IEA Governments in Energy*, 1996, International Energy Agency, Paris *cited in* BHATTACHARRYA, S.C., Energy Economics: Concepts, Issues, Markets and Governance, Springer, London, 2011, p.295; POSNER, R.A., ‘Theories of Economic Regulation’, (1974), 5 *The Bell Journal of Economics and Management Science*, pp.335-358, p.335; STIGLER, G.J., ‘The Theory of Economic Regulation’, (1971), 2 *The Bell Journal of Economics and Management Science*, pp.3-21, p.3; LEVI-FAUR, D., ‘Regulation and Regulatory Governance’, February 2010, Jerusalem Papers in Regulation & Governance, Working Paper No. 1, <https://www.researchgate.net/profile/David_Levi-Faur/publication/254908793_Regulation_Regulatory_Governance/links/54ec471a0cf27fbfd76f0d6c/Regulation-Regulatory-Governance.pdf> accessed 09.10.2018; HUNT S., Making Competition Work in Electricity Markets, *Supra* note 6, pp.7-8.

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and results of liberalisation are of enormous importance within the context of this thesis. For this reason, this part of study deals with the previous literature written on liberalisation in electricity markets. Liberalisation in electricity markets is therefore examined below to a certain extent in order to show how approaches to generation adequacy have evolved.

3.1.1 What is the Underlying Reasons for Liberalization?

A massive body of literature exists concerning liberalisation in electricity markets. In fact, it is technically impossible to talk about all the works written on this matter one by one. Some of the main studies of this literature can be put in order as follows: Jamasb and Pollitt,[15] Joskow,[16] Newbery,[17] Hunt,[18] Williams and Ghanadan,[19] Chao et al.,[20] Sioshansi and Pfaffenberger,[21] and the Intentational Energy Agency (IEA).[22] The literature reveals that there are significant motivational differences between developed and developing countries for liberalising their electricity markets. On the one hand, in developing countries the core aim of liberalisation in electricity markets was to attract private investment including foreign direct investment to the

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[15] JAMASB T. and POLLITT M., 'Electricity Market Reform in the European Union: Review of Progress toward Liberalisation & Integration', (2005), *The Energy Journal*, Vol. 26, Special Issue: European Electricity Liberalisation, pp. 11-41.

[16] JOSKOW P. L., 'Lessons Learned From Electricity Market Liberalisation', (2008), *The Energy Journal*, Vol. 29, Special Issue, pp. 09-42, <https://economics.mit.edu/files/2093> accessed 28.06.2017; JOSKOW P. L., 'Introducing Competition into Regulated Network Industries: from Hierarchies to Markets in Electricity', (1996), *Industrial and Corporate Change,* Volume 5, Issue 2, pp. 341–382.

[17] NEWBERY D., 'Privatisation and liberalisation of network utilities', (1997), 41 *European Economic Review*, pp. 357-383; NEWBERY D., 'Problems of liberalising the electricity markets', (2002), 46 *European Economic Review*, pp. 919-927; NEWBERY D., 'Electricity liberalisation in Britain: The quest for a satisfactory wholesale market design', (2005), *The Energy Journal,* Vol. 26, Special Issue: European Electricity Liberalisation, pp. 43-70.

[18] HUNT S., *Making Competition Work in Electricity Market, Supra* note 6.

[19] WILLIAMS J. H. and GHANADAN R., 'Electricity reform in developing and transition countries: A reappraisial', (2006), 31 *Energy*, pp. 815-844.

[20] CHAO H. et al., 'Reevaluation of Vertical Integration and Unbundling in Restructured Electricity Markets', in SIOSHANSI F. P. (ed.), *Competitive Electricity Markets: Design, Implementation, Performance*, Elsevier, the UK, 2008, pp.27-64.

[21] SIOSHANSI F. P. and PFAFFENBERGER W., 'Why Restructure Electricity Markets?', in F. P. SIOSHANSI and PFAFFENBERGER W., *Electricity Market Reform: An International Perspective*, Elsevier, the UK, 2006, pp. 35-48.

[22] IEA, 'Electricity Market Reform: An IEA Handbook', OECD/IEA, Paris 1999, <http://abraceel.com.br/_anexos/mreform99.pdf> accessed 15.02.2018.

power sector so as to meet the deficit of government funds.[23] On the other hand, the main aim of liberalisation in the electricity markets of developed countries was undoubtedly to make competition work in order to decrease electricity prices for final consumers by enhancing efficiency and decreasing production costs.[24] This is based upon a very basic and generally accepted belief about competition. This belief clearly found its voice in the former Governor of California, Pete Wilson's speech, when he signed the Electric Utility Industry Restructuring Act (Assembly Bill 1890), which became law in September 1996, to make generation of electricity competitive in California. Wilson said that:

> "Every time a resident of this state flicks on the electric switch, they pay 40 percent more than residents across the United States… The legislation I am signing today will end that by ushering in a new era of competition, making California the first state in the nation to dismantle its electric monopoly. This landmark legislation is a major step in our efforts to guarantee lower rates, provide consumer choice and offer reliable service, so no one literally is left in the dark."[25]

In and of itself, the words of Wilson reflected the general expectation of developed countries from the liberalisation of their electricity markets. According to this expectation, liberalised electricity markets would make electricity prices cheaper for consumers by introducing competition. In this sense, Joskow noted that:

> "The overriding reform goal is to create new governance arrangements for the electricity sector that will provide long-term benefits to consumers. These

[23] BELYAEV L. S., *Electricity Market Reforms: Economics and Policy Challenges,* Springer, New York, 2011, p.2.

[24] *ibid.*

[25] WALSH S. and LOW R., 'Wilson Signs Historic Legislation Restructuring Electric Industry Ending California's Utility Monopoly Creating the Nation's First Plan to Deregulate Electricity through Competition', 23.09.1996, <http://www.sec.gov/Archives/edgar/data/827052/0000827052-96-000039.txt> accessed 20.08.2015.

benefits will accrue by relying on competitive wholesale markets for power to provide better incentives for controlling capital and operating costs of new and existing generating capacity, to encourage innovation in power supply technologies, and to shift the risks of technology choice, construction cost and operating "mistakes" to suppliers and away from consumers. Retail competition, or "customer choice" would allow consumers to choose the supplier offering the price/service quality combination that best met their needs, and competing retail suppliers would provide an enhanced array of retail service products, risk management, demand management, and new opportunities for service quality differentiation based on individual consumer preferences."[26]

3.1.2 'Standard Prescription'[27] of Liberalisation in Electricity Markets

Liberalisation in electricity markets, as shown above, had different motivations for developed and developing countries; however, both developed and developing countries have strictly applied a 'standard prescription' for liberalising their electricity markets. As indicated by Newbery, the motto 'competition where feasible, regulation where not' has been applied to electricity markets.[28] In doing so, electricity market liberalisation in many countries, most of which have been effectively templates taken from the UK experiences,[29] generally started with unbundling vertically-integrated electricity industry. An electricity systems consists of four

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[26] JOSKOW P. L., 'Lessons Learned from Electricity Market Liberalisation', *Supra* note 16, p.9.

[27] The term 'standard prescription' has been used by some authors to define a model that has been widely recognised and employed as a guideline - that was previously used in some countries and achieved success - to liberalise electricity markets.

[28] NEWBERY D., 'The relationship between regulation and competition policy for network utilities', 28.10.2003, <http://www.jftc.go.jp/cprc/koukai/sympo/2003symposium/2003agenda.files/agenda7.pdf> accessed 10.03.2018, p.7.

[29] Newbery stated that "the English model of vertical separation is rapidly becoming the reference model for reform in developed economies where Electricity Supply Industries (ESI) is mature provided that the system is large enough to support a number of competing generation companies […]". *See* NEWBERY D., *Privatization, Restructuring and Regulation of Network Utilities,* The MIT Press, London, 3rd ed., 2002, p.199.

interdependent functions, respectively generation (production and conversion), (long-distance) transmission, distribution, and (retail) supply.[30] The electricity market reforms after 1990 contained the following main stages: restructuring, privatisation, regulation, and competition.[31] More particularly, this necessitated the vertical separation of the generation, transmission, distribution, and retail functions and the privatisation of key public-owned companies.[32] Generally speaking, the way of deregulation in all network industries such as railway, telecommunication and natural gas has the same characteristics in many approaches. As Joskow rightly presented, "the standard neoclassical public policy prescription for liberalising vertically and horizontally integrated 'natural monopoly' industries is fairly straightforward."[33] This 'standard prescription' contains the privatisation of state-owned companies, the separation of potentially competitive parts of the market from the natural monopoly ones, the price regulation for access so as to preclude discrimination, measures for ownership unbundling between vertical segments, liberalisation and enabling of market access to the competitive activities, incentive-based regulation in natural monopoly segments, and direct entrance of retailers to wholesale industries.[34] The intended consequences from this 'standard prescription' is obviously improved service quality and lower prices or at least limits to price rises through competitive pressures, which may not be realised at all times.[35] In a similar vein, the IEA also put forward that the main aim of liberalisation in electricity markets was to enhance economic efficiency of electricity

[30] JAMASB T. and POLLITT M., 'Electricity sector liberalisation and innovation: An analysis of the UK`s patenting activities', (2011), 40 *Research Policy* pp. 309-324, p.310. With technological innovation, metering, which is generally accepted within the supply function, may also be regarded as another separate function. As evidence of this, it can be shown that various countries such as the Czech Republic, Germany, Lithuania and Romania already own their independent metering operator. *See* European Commission, 'The functioning of retail electricity market for consumers in the European Union', Final Report, November 2010, <http://ec.europa.eu/consumers/consumer_research/market_studies/docs/retail_electricity_full_study_en.pdf> accessed 18.03.2013.

[31] *Ibid*.

[32] *ibid*.

[33] JOSKOW P. L., 'Introducing Competition into Regulated Network Industries: from Hierarchies to Markets in Electricity', *Supra* note 16.

[34] ASQUER A., 'Liberalisation and regulation reform of network industries: A comparative analysis of Italian public utilities', (2011), 19 *Utilities Policy,* pp. 172-184.

[35] *ibid*.

supply.[36] It was predicted that introducing competition in generation and supply segments would improve efficiency in production via developing allocative efficiency and decreasing operating costs.[37]

3.1.3 Liberalisation in the EU Electricity Markets: The Emergence of the EU Energy-only Markets[38]

The structure of the European electricity markets has been based on two pillars: Energy-only markets and market coupling.[39] This structure is called the Target Model of the EU electricity markets. The birth of the EU energy-only markets has been achieved through a series of liberalisation reforms. These liberalisation reforms first began in some Member States, such as the United Kingdom (the UK), but then through a series of Directives, the European Commission (the Commission) provided Member States central orientation. The Electricity Market Directives that took effect in 1996, 2003 and 2009 served as central directions for how Member States would regulate their electricity markets. Legislative packages since 1996 have opened the sector to vertical unbundling and competition.[40] It should be accepted that the project of establishing

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[36] IEA, 'Energy Market Reform: Power Generation Investment in Electricity Markets', OECD/IEA, Paris, 2003, <https://www.hks.harvard.edu/hepg/Papers/Fraser.gen.invest.elec.mkts.1203.pdf> accessed 25.02.2018, p.21.

[37] *ibid*.

[38] Here, the term "energy-only market" is used with the same meaning of liberalised electricity markets. Creating energy-only markets are a natural result or basic aim of liberalisation reforms. According to Doorman, an energy-only market is a market design that has no explicit provisions concerning generation adequacy. Hogan defined energy-only market in the electricity industry as relying on market incentives for new investment which appears via the mainly voluntary contracts of market players. On this matter, Hogan critically noted that energy-only markets do not mean that there are no regulatory rules that manage the electricity market. Because of the sui generis characteristics of electricity markets, some necessary ancillary services and associated regulatory rules such as black start capability, regulation services and voltage support must be put in place to successfully operate electricity systems. *See* DOORMAN G. L., 'Peaking Capacity In Restructured Power Systems', Norwegian University of Science and Technology Faculty of Electrical Engineering and Telecommunications Department of Electrical Power Engineering, PhD Thesis, <https://core.ac.uk/download/pdf/30862561.pdf> accessed 08.01.2018, p. 154. and HOGAN W.W., 'On an "Energy Only" Electricity Market Design for Resource Adequacy', 23.09.2005, <https://sites.hks.harvard.edu/fs/whogan/Hogan_Energy_Only_092305.pdf> accessed 04.11.2013.

39 GLACHANT J. M. and RUESTER S., 'The EU internal electricity market: Done forever?', (2014), 30 Utilities Policy, pp.1-7, p.1.

[40] NEWBERY D. et al, 'Market design for a high-renewables European electricity system', EPRG Working Paper 1711, Cambridge Working Paper in Economics 1726, June 2017,

the Internal Electricity Market (IEM) in the EU has been gaining considerable success. However, it has also become clear that the current structure of the European electricity markets cannot deal with problems derived from the energy transition process and other structural problems that are specific to the electricity market. The Commission has very clearly stated why the current market structure should change:

> "The existing market concept dates from an era in which large-scale, centralised power plants, largely fuelled by fossil fuels, had the key aim of supplying every home and business in a limited area - typically a Member State – with as much electricity as they wanted, and in which consumers – households, businesses and industry – were perceived as passive. Today, the move towards decentralised generation increases the number of involved players and changes the existing market roles. The electricity market needs to adapt this new reality; it needs to fully integrate all market players – including flexible demand, energy service providers and renewables."[41]

This was undoubtedly not expected from the liberalisation of electricity markets. The reason is simple. Energy-only markets emerging with liberalisation was supposed to work like other markets. It was assumed that energy-only markets could automatically attract new investment at the required level, provide sufficient electricity generation according to consumer demands and perform innovation needed by the electricity markets. But it was a little too much wishful thinking to assume that electricity markets could properly function without any state intervention. While this optimism was even too much for those markets that have relatively less structural problems, it was obvious that electricity markets would need a level of state intervention to function properly. This idea does not necessarily mean a categorical opposing to

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<https://www.eprg.group.cam.ac.uk/wp-content/uploads/2017/06/1711-Text.pdf> accessed 26.02.2018, p.5.

[41] European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM (2015) 340 final, p.3.

the free market mechanism. The success of free market mechanisms in theory and in practice in terms of enhancing efficiency, improving innovation and quality is a fact. So, assuming this mechanism will also work in electricity markets is not so incomprehensible at first glance. Nonetheless, many problems have arisen especially due to the unique characteristics of the electricity markets. These problems and their results are briefly mentioned below.

3.1.3.1 Problem Definition

Karl Popper, one of the most important and influential science philosophers of the 20th century, stated that both natural and social sciences always focus on problems.[42] In other words, as Greek philosophers say, both natural and social sciences are driven by people's curiosity.[43] Indeed, it is not possible for a researcher to obtain valuable and remarkable results without making a specific problem definition at the beginning of the research journey. In this sense, for researchers studying European electricity markets, CRMs are at the top of a list of the most thought-provoking topics in recent years. The reason is simple: The fast-growing number of CRMs among Member Stares are causing many problems that need to be resolved for the European electricity markets. Therefore, many researchers from academic circles, the electricity sector and/or relevant public institutions have focused on rising generation adequacy concerns in the EU within the context of CRMs.

In fact, seeking adequate generation capacity has always been a problem/concern since electricity market liberalisation started. As discussed above, electricity markets were structured as vertically integrated monopolies for many years due to several fundamental economic reasons including the existence of economies of scale, the consideration of public service obligations for communities and the feature of electricity as a non-storable product.[44] Electricity markets, especially for wholesale trading, have been deregulated in many countries around the world

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[42] POPPER K.R., *Hayat Problem Çözmektir: Bilgi, Tarih ve Politika Üzerine*, 7th Edition, Yapı Kredi Yayınları, İstanbul, 2017, p.15. (In Turkish)
[43] *Ibid.*
[44] VENTOSA M. et al, 'Power System Economics', in PÉREZ-ARRIAGA I. J. (ed.), *Regulation of the Power Sector,* Springer, London 2013, p.47, pp.47-123.

since the early 1980s. The very well-known purpose of these reforms has been to achieve economic efficiency. Nevertheless, since the beginning of the liberalisation process in Chile in 1982, the capability of electricity markets to provide adequate generation to ensure reliability has always been a worrisome question for regulators.[45] This issue has unquestionably gained significance over time, and it is nowadays the key topic on energy regulators' agendas.[46] Generation capacity shortages took places in Californian, New Zealand, Scandinavian and Italian electricity markets in the 2000s, increasing concerns whether liberalised electricity markets could provide satisfactorily strong and early signals for investments.[47] It is no doubt true that these worries will gradually increase in the coming years. According to the IEA, the total demand for electricity in the world increases nearly twice as fast as total energy demand, and the main challenge to deal with this rising demand is becoming more complex with the investment needed to replace aged electricity infrastructure.[48] Furthermore, the IEA suggests that "of the new generation capacity that is built to 2035, around one-third is needed to replace plants that are retired."[49] Table 1 below explicitly shows different demand growth structures for different regions and scenarios between 2010 and 2035.[50] This table puts forward that, in the New Policies Scenario, demand for electricity enlarges by over 70% between 2010 and 2035, at an average (annual) rate of growth of 2.2%.[51]

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[45] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets' in PEREZ-ARRIAGA I.J. (ed.), *Regulation of the Power Sector*, Springer, London, 2013, p.584, pp. 581-622.
[46] *Ibid*., p.584.
[47] DE VRIES L., 'Generation Adequacy: Helping the Market Do Its Job', (2007), 15 *Utilities Policy* pp. 20-35.
[48] IEA, 'World Energy Outlook 2012', OECD/IEA, Paris, 2012, <https://www.iea.org/publications/freepublications/publication/WEO2012_free.pdf> accessed 15.06.2016, p.28.
[49] *ibid.*
[50] *ibid*., p.180.
[51] *ibid.*

	1990	2010	New Policies 2035	New Policies CAAGR 2010-35	Current Policies 2035	Current Policies CAAGR 2010-35	450 Scenario 2035	450 Scenario CAAGR 2010-35
OECD	6 592	9 618	11 956	0.9%	12 635	1.1%	11 013	0.5%
Americas	3 255	4 659	5 939	1.0%	6 133	1.1%	5 442	0.6%
United States	2 713	3 893	4 769	0.8%	4 892	0.9%	4 374	0.5%
Europe	2 321	3 232	3 938	0.8%	4 247	1.1%	3 676	0.5%
Asia Oceania	1 016	1 727	2 078	0.7%	2 255	1.1%	1 895	0.4%
Japan	758	1 017	1 095	0.3%	1 201	0.7%	976	-0.2%
Non-OECD	3 494	8 825	19 903	3.3%	22 254	3.8%	16 931	2.6%
E. Europe/Eurasia	1 585	1 350	1 978	1.5%	2 214	2.0%	1 754	1.1%
Russia	909	834	1 234	1.6%	1 405	2.1%	1 092	1.1%
Asia	1 049	5 352	13 705	3.8%	15 431	4.3%	11 438	3.1%
China	558	3 668	8 810	3.6%	10 149	4.2%	7 167	2.7%
India	212	693	2 463	5.2%	2 617	5.5%	2 096	4.5%
Middle East	190	680	1 466	3.1%	1 609	3.5%	1 260	2.5%
Africa	262	569	1 195	3.0%	1 289	3.3%	1 077	2.6%
Latin America	407	875	1 559	2.3%	1 711	2.7%	1 401	1.9%
Brazil	214	451	824	2.4%	904	2.8%	744	2.0%
World	10 086	18 443	31 859	2.2%	34 889	2.6%	27 944	1.7%
European Union	2 227	2 907	3 415	0.6%	3 694	1.0%	3 220	0.4%

* Electricity demand is calculated as the total gross electricity generated less own use in the production of electricity, less transmission and distribution losses.

Note: TWh = terawatt-hours; CAAGR = compound average annual growth rate.

Table 1 Electricity demand by region and scenario[52]

Capacity requirements to meet the above-mentioned increasing demand and to replace retiring infrastructure is understandably enormous over the projection period. The added capacity required in total for a given level of demand hinges upon the type of plant, since their availability to generate electricity diverges.[53] Furthermore, in terms of the New Policies Scenario, world-wide installed capacity is estimated to grow from 5,429 GW in 2011 to around 9,340 GW by 2035 – a net rise of about 3,900 GW, or nearly three-quarters.[54] Because of the fact that 1,980 GW is expected to be retired up to 2035, nearly one-third of new capacity will be employed to replace the retired capacity.[55] Figure 1 below illustrates the retirements likely to happen between 2012-

[52] *ibid.,* p.183.
[53] *ibid.*
[54] *Ibid.,* p.184.
[55] *ibid.*

2035 for virutally all types of generation source. According to this figure, the most significant change will be encountered in oil-based generation. It can be easily seen that the retirements level of oil-based generation will be more than the oil-based capacity additions. In sum, until 2035, about 250 GW of capacity decline will be experienced for this source alone. For coal, although the level of capacity addition will be faster than retirements up to 2025, it is projected that this trend will weaken after 2025. These numbers can be thought of as the natural result of a global intention to generate electricity with more environmentally friendly sources. The projected capacity additions from RESs (*See* Figure 1) cleary indicate this global intention.

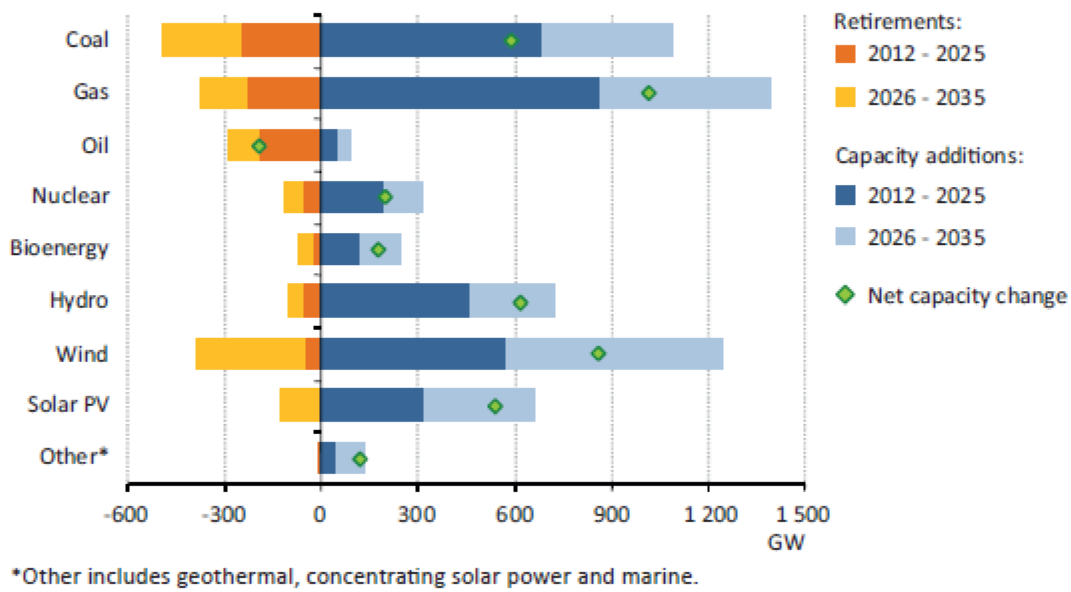

Figure 1 Power generation gross capacity additions and retirements in the New Policies Scenario, 2012-2035[56]

Unsurprisingly, to meet this rising demand and to replace the retired capacity, a susbtantial amount of investment will be required both at the global and national scale. According to the IEAs estimates, total investment in the electricity sector should be $16.9 trillion (in year-2011 dollars) between 2012 and 2035, approximately equal to the Gross Domestic Product (GDP) of the whole EU in 2011, which is also equal to 45% of all energy sector investment.[57] Investment in

[56] *ibid.*
[57] *ibid.,* p. 193.

electricity generation constitutes 57% of total electricity sector investment, of which over 60% of which for renewables.[58]

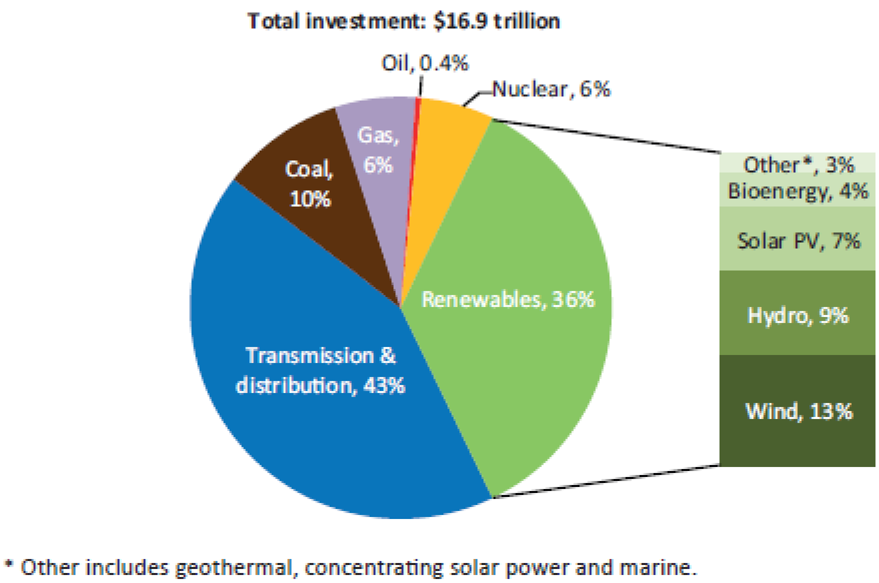

Figure 2 Power sector cumulative investment by type in the New Policies Scenario[59]

In regional-based, for instance, North America including Canada, the US and Mexico requires about $1 trillion (US) investment in generation, transmission and distribution facilities up to 2020 to meet increasing demand, according to a report published by the Fraser Institute, Canada's leading public policy think-tank.[60] In another projection made for Latin America and the Caribbean, total demand for electricity will increase by 100% between 2008 and 2030.[61] This huge increase undoubtedly has an implication for the investment needs for Latin American Countries,

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[58] *ibid.*
[59] *ibid.*, p.195.
[60] FRASER INSTITUTE, 'Barriers to investment in North American electricity infrastructure will saddle consumers with higher electricity costs', 30.05.2011, <http://www.exchangemagazine.com/morningpost/2011/week22/Monday/053013.htm> accessed 10.03.2018.
[61] YEPEZ-GARCIA R.A., JOHNSON T.M. and ANDRES L.A., 'Meeting the Electricity Supply/Demand Balance in Latin America & the Caribbean', The World Bank, June 2011, <http://documents.worldbank.org/curated/en/240281468277499650/pdf/634360PUB0Meet01518B0EXTOP0ID018819.pdf> accessed 14.06.2016, p.59.

which is about $430 billion (US) between 2008 and 2030.[62] In a similar vein, it is a fact that major investment is required for the EU to ensure low-carbon electricity targets. According to EU official documents, it is estimated that around €1 trillion must be invested in energy infrastructure including electricity and gas distribution, transmission, storage and smart grids until 2020 to reach the current policy objectives.[63] Furthermore, it is estimated that aggregate investment expenditure for electricity generation may reach over €3 trillion up to 2050, according to the high RES scenario.[64] Apart from these impressive statistics, many national statistics also put forward the huge investment needs in electricity sector, especially for generation and transmission segments. For the UK alone, it is projected that around £110 billion in investment in power transmission and generation is required until the end of this decade.[65]

All these statistics show that virtually all countries worldwide are faced with a real challenge to produce adequate investment to ensure generation adequacy. Some may argue that electricity demand is rising very slowly, especially in developed economies such as European countries. Indeed, as Table 1 above illustrated, Europe's electricity demand shows very little increases for all scenarios. In fact, electricity demand in Europe might not even reach the level evidenced before the 2008 Global Financial Crisis.[66] So, it can be assumed that there would not be a serious

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[62] *ibid.* p.63.

[63] European Commission, Commission Staff Working Document, Impact Assessment, Accompanying document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 'Energy Infrastructure – Priorities for 2020 and Beyond – A Blueprint for an Integrated European Energy Network', Brussels, 17.11.2010, SEC(2010) 1395 final, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52010SC1395&from=ga> accessed 14.05.2013.

[64] European Commission, Commission Staff Working Paper, Impact Assessment, Accompanying the document Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, 'Energy Roadmap 2050', Brussels, 15.12.2011, SEC(2011) 1565 final
Part 1/2 <http://ec.europa.eu/energy/energy2020/roadmap/doc/roadmap2050_ia_20120430_en.pdf> accessed 14.05.2013.

[65] DECC, 'Electricity Market Reform: Policy Overview', May 2012, <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48371/5349-electricity-market-reform-policy-overview.pdf> accessed 14.05.2013, p.3.

[66] *See*, Chapter 3 – Subheading "3.1.2.4 The Global Financial Crisis 2008".

problem concerning generation adequacy in such a low electricity demand increase. However, it can be said that the main reason for the huge investment need in the electricity market, especially in Europe, is not related to increasing demand. This investment need can be explained by three main reasons: (1) the need to change the ageing electrical infrastructure; (2) renewable energy investments to achieve climate change targets; and (3) back-up power plant investments that must be made to solve the increasing intermittency problem. On this issue, the IEA notes:

> "The relationship between electricity demand and generating capacity is set to change: every new unit of generation is likely to necessitate the provision of 40% more capacity as over the period 1990-2010, as the renewables share of capacity soars. The reason is that the capacity factor of renewables such as solar and wind is lower than that of thermal power, the preferred plant choice of the earlier period. Accordingly, installed power capacity is projected to approach 11 200 GW in 2040. Renewables account for two-thirds of the increase."[67]

This challenge leads many governments throughout the world to ask whether market mechanisms themselves can produce that much investment. The market ideally should be sufficient by itself to attract enough investment as well-known classical market theory[68] claims that it sends the right signals to guide investors in whether they should invest or not. Thus, there is no extra job in classical market theory to create enough investment: Markets can provide whatever is required. However, a range of factors specific to electricity markets serve to prevent this outcome from being successful.[69] Indeed, it is quite controversial to think that any market can function perfectly without any government intervention. In this regard, Rodrik, contrary to the well-known classical market concept, indicates that:

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[67] IEA, 'World Energy Outlook 2016', OECD/IEA, Paris, 2016, p.241.

[68] The concept of the market, according to the neo-classical economic approach, is established on the assumption that under certain circumstances markets work as self-regulating and self-correcting machines. For further discussion, *See*, GILPIN R., *Global Political Economy: Understanding the International Economic Order,* Chapter 3, Princeton University Press, New Jersey, 2001.

[69] VAZQUEZ C. et al, 'A market approach to long-term security of supply', (2002), 17 *IEEE Transactions on Power Systems*, pp. 349-357.

> "Markets are not self-creating, self-regulating, self-stabilizing or self-legitimizing. Every well-functioning market economy blends state and market, laissez-faire and intervention. The precise mix depends on each nation`s preferences, its international position, and its historical trajectory."[70]

He also shows this fact as the requirement and justification for market-supporting institutions.[71] According to him, each market-supporting institution is constituted for responding to different market failures, and they can be ordered as property rights, institutions for conflict management, institutions for social insurance, institutions for macroeconomic stabilisation and regulatory rights.[72] In that case, for a market with many deficiencies such as the electricity market, government intervention is necessary in many cases.

3.2.3.1.1 Main Imperfections and Challenges of the Electricity Markets in the EU

Since the main imperfections and challenges of electricity markets are broadly analysed under Chapter 2 and Chapter 3, they will only be dealt with briefly to show how they affect and create problems for generation adequacy.

1- *Public Goods Characteristic of Reliability of Electricity Supply:* Reliability of electricity supply has a public good characteristic. Many researchers indicate this feature of electricity markets. Within the framework of this thesis, the most important practical consequence of the reliability of electricity supply as a property of public good is that the market mechanism cannot guarantee generation adequacy without regulatory intervention.

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[70] RODRIK D., *The Globalization Paradox: Why Global Markets, States and Democracy Can`t Coexist?,* Oxford University Press, New York, 2011, p. 20.
[71] *Ibid*., p. 156
[72] *ibid*.

2- *The Missing Money Problem:* The missing money problem is one of the most notable concepts of energy-only electricity markets. So many scholars have agreed that the underlying cause of increased generation adequacy concerns is the missing money problem. In summary, the lack of income that results from the inability of electricity prices to rise sufficiently due to the explicit or implicit price cap regulation is called the missing money problem.

3- *The Rise of Intermittency:* The increasing share of RESs, particularly solar and wind power, within generation mixes has created a relatively new type of generation adequacy concern across the world. The rise of intermittency has an exacerbating effect on the missing money problem. This effect has been specifically felt in many European countries. Since there have been generous support schemes for RESs in the EU for many decades, the share of intermittent RESs in the European countries has dramatically increased in last decade. Due to this reason, the rise of intermittency has started to pose generation adequacy for several European countries at risk.

4- *Lack of Adequate Long-term Contracts in Electricity Markets:* Long-term contracts have a critical role to ensure generation adequacy in energy-only markets. However, due to some reasons that will be discussed in Chapter 2, energy-only markets cannot produce adequate levels of long-term contracts. This argument is valid even in the most liquid electricity markets of the EU such as the UK and Germany. Thus, ensuring generation adequacy in energy-only markets cannot be ensured through these contracts.

5- *Low-Carbon Prices:* Carbon prices in the EU decreased significantly in the last decade. Logically, this has harmfully disturbed the competitiveness of gas-power plants contra coal-power stations, in favour of coal.[73] Likewise, the IEA indicated that carbon prices have declined by between €4-7 per tonne of CO2 during recent years.[74] This situation has had a negative effect for ensuring generation adequacy in EU Member States.

[73] European Commission, `Energy Economic Developments: Investment Perspectives in Electricity Markets`, Institutional Paper 003, July 2015, <https://ec.europa.eu/info/sites/info/files/file_import/ip003_en_2.pdf> accessed 26.02.2018, p.14.
[74] IEA, 'World Energy Outlook 2016', *Supra* note 67, p.270.

6- *Phasing out Nuclear and Coal Power Plants:* Due to environmental concerns, ageing infrastructure and increasing public awareness, some European governments such as Germany and Belgium have unilaterally decided to shut down their nuclear power plants. These unilateral decisions, of course, have effects beyond the boundaries of the countries where decisions are taken. In highly integrated electricity markets such as the EU, decisions taken at the national level will inevitably affect neigbouring electricity markets. Therefore, decisions regarding the closure of nuclear and coal power plants have increased generation adequacy concerns across European countries.

7- *Flood of cheap shale gas:* After the US shale gas revolution, the world's coal supply surplus has made the situation worse for gas power plants in terms of competitiveness in the EU. For this reason, there has been a major transition from natural gas to coal for electricity generation in Europe. There is no doubt that this was a temporary situation. However, the shale gas effect increased generation adequacy concerns among Member States in terms of attracting new gas power plant investments and/or keeping existing gas power plants online.

8- *The Global Financial Crisis 2008:* The 2008 crisis, which was the biggest financial crisis since the 1929 Global Economic Crisis in terms of its impact, has caused many devastating effects as well as bad consequences for European electricity markets. As a result of the economic downturn, electricity demand in Member States have dramatically decreased. Shrinking demand for electricity was so great that even though ten years have passed, 2008 electricity demand levels have still not been reached. Consequently, electricity prices were put under pressure owing to declining demand. This had unsurprisingly negative impacts on the profitability of current power plants and/or the profit expectations of future investors. Naturally, generation adequacy concerns were increased because of the 2008 Global Financial Crisis.

As a result of the reasons briefly explained above, liberalised electricity markets, in other words energy-only markets may not deliver sufficient generation capacity to ensure generation adequacy in the long-run. In addition to the chronic problems in electricity markets mentioned above, the energy transition, which has become more and more influential in recent years, creates new and difficult challenges to ensure generation adequacy. All these challenges concerning energy only markets bring about a need to establish CRMs to incentivise adequate investment for generation adequacy. Many Member States in the EU have also felt the same requirement for their electricity markets in recent years. So, Member States including the UK, Germany, France, Italy, Belgium, Poland, Denmark, Spain, Portugal, Greece, Croatia, Sweden and Ireland have established their own CRMs in their jurisdictions. All the CRMs mentioned above have been introduced via a unilateral approach. This means that Member States have either never considered or sufficiently considered neighbour countries' contributions to their generation adequacy when they designed their CRMs. Nonetheless, establishing CRMs with a unilateral approach in interconnected electricity markets, as in Europe, may lead to inefficiencies and distort cross-border trade. These developments cause the controversial question of creating a regulatory framework to integrate European CRMs. This was defined as the main research problem to be answered within the context of this thesis. With this understanding, the research question raised by this thesis are set out in the next section.

4. Research Question

- What regulatory framework is required to ensure generation adequacy in energy-only markets, and to integrate unilaterally established Capacity Remuneration Mechanisms in the EU in compliance with the spirit of the Internal Electricity Market?

5. Methodology

This study adopts a desktop-based research methodology. As part of this desktop-based research, a qualitative research approach is adopted. Qualitative research is an umbrella expression used for a broad mixture of methodologies and methods for the study of social life.[75]

[75] SALDAÑA, J., *Fundamentals of Qualitative Research*, New York: Oxford University Press, 2011.

The data or evidence collected throughout a qualitative study is typically non-quantitative in nature, including materials such as interview notes, fieldnotes, websites, documents and visual materials like artifacts, photographs and video recordings.[76] In this sense, it could be said that there are different types of data collection methods involved in a qualitative study: (1) Interviews; (2) As a mixed method: Interviews, participant observation and written survey; and (3) Relying solely on written documents created by humans.[77] In this thesis, as a data collection method, the third approach is implemented. That is, academic papers, official reports prepared by governments and supranational authorities, newspapers and related websites are employed as the main sources for this thesis. This process has essentially served as a bridge between defining the research problem and how it could be solved. Here, it should be noted that as indicated above, by their nature, qualitative researches implement non-quantitative methods to solve the problem they define. However, this does not mean that qualitative researches should avoid any sources that include or use quantitative information. Related to this, Saldana indicates that:

> "Qualitative researchers should not shy away from researching and including any statistical information relevant to their studies. This is not to suggest that mixed methods studies should always be the norm, but sometimes numbers can add insight, texture, and context to the repository of qualitative data in a report."[78]

Indeed, many quantitative sources are employed throughout this thesis. This is important to obtain a better understanding of the basic arguments that this thesis seeks to defend.

Further, a deductive approach is adopted for this thesis. The deductive method is "a process of reasoning from the general to particular or from the universe to individual, from given premises

[76] *ibid*.
[77] *ibid*.
[78] *ibid*., p.61.

to necessary conclusions."[79] This method is also called as analytical, abstract or *a priori*.[80] In this thesis, Chapter 2 is devoted to exploring the main reasons why CRMs have been established around the world. This exploration process is supported by analysing both theoretical studies and real-world experiences across the world. In light of the deductions derived from Chapter 2, CRMs established in EU Member States in recent years are analysed in Chapter 3. Thus, a comparison would be made in Chapter 3 between what the Conceptual Framework (Chapter 2) suggests regarding the reasons for the establishment of the CRMs and the reasons for the establishment of European CRMs.

Chapter 4, the last main chapter of the thesis, fundamentally adopts a normative approach. That is, Chapter 4 provides a "What ought to be" list for preventing the harmful effects of unilaterally established CRMs in the EU. To do this, Chapter 4 analyses the question of why integrating European CRMs is a necessity from both economic and legal perspectives. Within the context of legal analysis, the Commission's Decisions concerning CRMs in Member States are individually handled. Examining these Cases/Decisions provides the legal basis of the integration requirement of European CRMs from practical life. The end of Chapter 4 is devoted to discussing the minimum regulatory requirements necessary to integrate the European CRMs. These regulatory requirements can be defined as the normative outcome of this thesis.

5.1 Limits of the Thesis

Every research has its own limits. Because of methodological and time constraints, researchers must clearly define the boundaries of their studies. This is necessary both to maintain the focus the thesis to handle certain subject within discipline and to prevent the research topic from digressing too much. Of course, keeping research that takes years to conduct such as a PhD thesis

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[79] Government of India, Ministry of Human Resource Development, Content for Postgraduate Courses, Module: Legal Reasoning, <http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/law/09._research_methodology/03._legal_reasoning_/et/8150_et_et.pdf> accessed 10.03.2018, p.4.

[80] *Ibid*.

on track is not always an easy task. Therefore, the limits of the thesis should be defined properly. The following are the limits/boundaries of this thesis:

- This study does not cover CRMs of Member States in detail. Rather, it covers just a general overview of each Member States' CRM. This is because it is not necessary to know each CRM in detail to answer the research question.

- This study is not an attempt to cover how to use CRMs to integrate intermittent RESs with electricity markets. However, it is believed that CRMs can be employed to integrate RESs. Therefore, this can be a further (future) research topic.

- Likewise, this thesis does not discuss the question of how to integrate alternative capacity resources such as demand side resources including energy efficiency measure and energy storage technologies into CRMs. This is indisputably a crucial topic to be handled and certainly its significance will gain importance in coming years. It can even be argued that CRMs will play a leading role in the development of alternative capacity sources and their participation in electricity markets. However, this issue is not dealt within this thesis in detail. It is defined as a further research area in the Conclusion chapter, Chapter 5.

6. Conclusion: Objective, Importance and Structure of the Thesis

This thesis was born, matured and written at the very heart of debates concerning CRMs in Europe. Writing a thesis in this type of environment has both advantages and disadvantages. On the one hand, it has advantages because, first, you can understand that the thesis will have the chance to make an original contribution. Second, constantly updated discussions on the subject are useful for keeping the curiosity alive, which is the most important issue for research. On the other hand, there are some disadvantages to write a thesis in an environment where debates about the subject has just emerged. The first disadvantage in this sense is undoubtedly the lack of literature. It is clear that there exists a substantial body of literature on CRMs both in the theoretical sense and in particular about the North East American electricity markets for a long time. Of course, it should not be forgotten that there is a significant body of literature on CRMs in South American countries such as the Colombian and Brazilian electricity markets. However, within the European context, it is obvious that the literature on CRMs is relatively narrow. This literature is either about the capacity payment mechanism that the UK implemented in the early period of liberalisation and ended at the beginning of 2000s, or is relevant to how Spain's existing capacity payment mechanism can be improved. Nonetheless, since CRMs emerged in this decade this has led to new and untested challenges for the European electricity markets, and relevant literature concerning these challenges was naturally limited at the beginning of this research. Another disadvantage of investigating and completing a thesis in an environment where debates about the research topic has just begun concerns perspective. That is, for a researcher it is dangerous to look at a research topic in the middle of debates in terms of objectivity. Albeit these disadvantages, it is believed that a comprehensive and timely contribution is made to the current literature concerning CRMs within the context of the European electricity markets.

The main objective of this thesis is to provide a workable regulatory framework to integrate European CRMs. As stated in the Problem Definition section above, as with other electricity markets around the world, electricity markets are in the middle of a great transition in Europe. Indeed, it can be said that the effects of this energy transition are felt more by the EU than in other parts of the world. This is a natural result of the decades-long energy policies of the EU to develop RESs. This huge transition naturally creates new and deep challenges. CRMs are one side of these new-born challenges for the EU. Comprehending the main motivations underlying the establishment and working principles of CRMs are crucial to understand the energy transition of electricity markets both in the EU and anywhere else in the world. Readers of this thesis, in this sense, will have the chance to recognise the recent developments in electricity markets within the context of CRMs. Further, by providing a workable regulatory framework, this thesis will promote the integration of European CRMs. Besides, it will help to understand new developments in the area of generation adequacy policies. Thus, those who want to understand

CRMs in general or within the context of the EU will benefit from the findings of this thesis. In other words, it is hoped that it will be useful for professionals from the energy sector, government officials from relevant departments and academicians interested in electricity markets.

This thesis consists of five chapters including the Introduction and the Conclusion chapters. So, in this research, there are three main chapters. Chapter 2 provides a Conceptual Framework for the rest of the thesis. A comprehensive literature review is also carried out in Chapter 2. This literature review makes it possible to identify the basic concepts of the research topic. In addition, this literature review explains the reasons behind the establishment of CRMs. Lastly, Chapter 2 analyses five basic types of CRMs including strategic reserves, capacity payments, capacity obligations, capacity markets and reliability options. Chapter 3 is devoted to analysing and revealing the reasons for the establishment of the European CRMs, particularly those adopted after 2010. A comparison is made between the establishment reasons provided by the Conceptual Framework in Chapter 2 and the establishment reasons of the European CRMs in Chapter 3. At the end of Chapter 3, CRMs established in different Member States are expressed by means of an illustrative table. Chapter 4 is the last main chapter of the research, and as such aims to answer the main research problem of this thesis. That is, throughout Chapter 4, the issue of integrating European CRMs is examined. First, the question of why the integration of the European CRMs is answered from economic and legal perspectives. Then, a regulatory framework that would enable the integration of the European CRMs is provided. At the end of Chapter 4, the relationship between European CRMs and the EUS is dealt with. The Conclusion Chapter, Chapter 5, evaluates the thesis and its main theoretical implications for the literature. It also provides some avenues for further research.

CHAPTER 2 - NOTES ON GENERATION ADEQUACY IN ENERGY-ONLY MARKETS: A CONCEPTUAL FRAMEWORK

1. Introduction

This chapter aims to provide a conceptual framework for the chapters 3 and 4 of the thesis. First of all, a terminological classification regarding reliability of electricity supply is made. Subsequently, the issue of generation adequacy in energy-only markets is examined. In this part, how energy-only markets in theory would ensure generation adequacy is initially assessed. Then, electricity market imperfections that may prevent energy-only markets from ensuring generation adequacy are analysed. Within this context, topics of the public good characteristic of generation adequacy, the missing money problem, the boom-and-bust cycle problem and forward markets are addressed, respectively. As a relatively new challenge, the increasing share of intermittent RESs in generation mixes is handled as an exacerbating effect of the missing money problem under the heading of the Missing Money Problem. Following on from the discussion concerning imperfections, this chapter will then briefly introduce CRMs in general terms. Finally, types of CRMs including strategic reserves, capacity payments, capacity obligations, capacity markets and reliability options are examined one by one. Examples from around the world are briefly mentioned during this review. In light of the literature, a table is presented which compares different types of CRMs in terms of various criteria.

2. What is Generation Adequacy? A Brief Discussion for Terminological Clarification

2.1 Energy Security: A General Overview

This thesis is directly about electricity markets. Therefore, as mentioned below, the terms fundamentally used in the context of electricity markets are employed throughout the thesis. Nevertheless, at this stage of the research, the concept of energy security is deserved to be analysed as an inclusive term. The concept of energy security was first defined upon the 1973 Oil Crisis, which was primarily handled the issue of how to manage any interruption of oil supplies from producing countries.[1] However, in the course of time, the concept of energy security had to cover the field of electricity market.[2] Consequently, in today's world, it could be argued that energy security is by definition covering the issue of security of electricity supply as well as gas and oil supply security.

As a well-known fact, energy security is a crucial target of energy policy in all countries. The EC, for instance, regards it as one of the three pillars of energy policy objectives alongside efficiency and sustainability.[3] In the Energy White Paper 2007, the UK put energy security as one of two energy policy priorities with climate change.[4] To show the importance of energy security, some may even claim that "security of energy supply must now be seen as taking priority over everything else, even climate change."[5] It is clear that the issue of energy security is not a new issue. It has been a repetitive concern since the Industrial Revolution took place. Compatible with this view, Joskow said that:[6]

> "there is one thing that has not changed since the early 1970s. If you cannot think of a reasoned rationale for some policy based on standard economic reasoning, then argue that the policy is necessary to promote 'energy security'".

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[1] YERGIN, D., 'Ensuring Energy Security', Foreign Affairs, Vol.85, 2006, <http://faculty.nps.edu/relooney/0_New_820.pdf> accessed 09.10.2018, p.4.

[2] *ibid*, p.2.

[3] European Commission, 'Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy', Brussels, 08.03.2006, COM(2006) 105 final, <http://europa.eu/documents/comm/green_papers/pdf/com2006_105_en.pdf> accessed 14.02.2013; European Commission, 'Green Paper: Towards a Secure, Sustainable and Competitive European Energy Network', Brussels, 13.11.2008, COM(2008) 782 final <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0782:FIN:EN:PDF> accessed 14.02.2013.

[4] Department of Trade and Industry, 'Meeting the Energy Challenge: A White Paper on Energy', May 2007, <http://webarchive.nationalarchives.gov.uk/20090609033751/http://www.berr.gov.uk/files/file39387.pdf> accessed 14.02.2013; FELLS I. and WHITMILL C., 'A Pragmatic Energy Policy for the UK', August 2008, <http://fellsassociates.awardspace.com/site/LinkedDocuments/Pragmatic%20Energy%20Policy1.pdf> accessed 14.02.2013, p.12.

[5] FELLS, I. and WHITMILL, C., 'A Pragmatic Energy Policy for the UK', *Supra* note 4, p. 4.

[6] JOSKOW, P.L., 'The U.S. Energy Security: Progress and Challenges, 1972-2009', <http://www.usaee.org/pdf/Aug09.pdf> accessed 16.02.2013, pp. 07-11, p. 11.

The first watershed regarding the notion of energy security was raised when Winston Churchill, as the first Lord of the Admiralty of the UK, decided to convert the Royal Navy from coal to oil.[7] The second sea-change in the customary concept of energy security came to the fore with the rise of natural gas as a new global energy business.[8] Yergin refers to the three basic factors that create the global natural gas market: (1) the overabundance of natural gas reserves and governments' appetite to convert these reserves to revenue; (2) rising LNG trade in the global context; and (3) the last but not least factor is the increasing demand that especially stems from electricity generation.[9] As mentioned, today, the definition of energy security should be made by considering all forms of energy sources including electricity. In this sense, the United Nations Development Programme (UNDP) defines energy security as "the availability of energy at all times in various forms, in sufficient quantities, and at affordable prices, without unacceptable or irreversible impact on the environment."[10] Further, the Asia-Pacific Economic Co-operation (APEC) indicates that "energy security in its economic context refers to the provision of reliable and adequate supply of energy at reasonable prices in order to sustain economic growth."[11] In a similar vein, the IEA defines energy security as "the uninterrupted availability of energy sources at an affordable price".[12] From this definition, it could be understand that energy security definition of IEA has three dimensions as affordable/competitive, reliable/uninterrupted and available/accessible supply of energy.[13] Furthermore, according to IEA, energy security has two time-based dimensions: (1) Long-term energy security primarily handles well-timed investments to provide energy in accordance with economic growths and sustainable environmental needs. (2) Short-term energy security deals with the capability of the energy system to respond rapidly to unexpected variations within the demand and supply balance.[14] As can be

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[7] YERGIN, D., 'Energy Security and Markets', in KALICKI J. H. and GOLDWYN D. L. (eds), *Energy & Security: Toward a New Foreign Policy Strategy,* The John Hopkins University Press, Washington, D.C., 2005, pp.51-64.
[8] *ibid.*
[9] *ibid.*
[10] United Nations Development Programme (UNDP), *World Energy Assessment*, New York: UNDP, (2004), p.42.
[11] Asia-Pacific Economic Co-operation (APEC), 'Energy Security in APEC: Assessing the Cost of Energy Supply, Disruptions and the Impacts of Alternative Energy Security Strategies', ABARE Research Report 05.2 for the APEC Energy Working Group, June 2005, p.1.
[12] IEA, *Energy Supply Security: Emergency Response of IEA Countries*, OECD/IEA, Paris, 2014, p.13.
[13] *ibid,* p. 14.
[14] *ibid*, p.13.

understood from this discussion, IEA approaches the concept of energy security in a similar vein with the concept of reliable supply of electricity discussed below. As mentioned, energy security is an inclusive concept that addresses the supply security of electricity, natural gas, oil and other energy sources.[15] Since this thesis is completely about electricity markets, throughout this study, it is preferred to use concepts such as reliability and generation adequacy which are mostly used in the context of electricity markets rather than using a general concept like energy security.

2.2 Reliability in Electricity Markets

Prior to discussing the question of why generation adequacy may be a matter of concern in liberalised electricity markets and why CRMs may be required to address the issue of generation adequacy, setting out a terminological classification regarding generation adequacy can be genuinely helpful for further analysis. This study stays loyal to the overall meaning evidenced in the extant literature concerning the term reliability. As the following discussion shows, there are sometimes different nomenclatures about the definition of reliability and its sub-concepts, and different words have been used to define the same concept. Even more, the same word has been used to define different concepts.

As noted by Newbery, there are three main aims of energy policy including security (reliability),[16] sustainability and affordability and out of these aims, policy makers give priority

[15] MANSOR, A.YBDS, Speech at the International Energy Security Forum, Kuala Lumpur, Malaysia, 12.11.2008, *cited in* BALAT M., 'Security of energy supply in Turkey: Challenges and solutions', (2010), 51 *Energy Conversion and Management*, pp.1998-2011, p. 1998; WINZER, C., 'Conceptualizing energy security', (2012), 46 *Energy Policy* pp. 36-48, p. 36.

[16] Sometimes the terms *security* and *reliability* can be used interchangeably. However, since literature on this issue predominantly regards reliability as an umbrella term, this paper follows what literature suggests. However, it should be keep in mind that some may use *security* (especially, in the form of *security of supply*) with the same meaning of *reliability*. For instance, Sioshansi defined reliability as a short term issue with the same meaning of security. *See,* SIOSHANSI F.P., 'Introduction: Electricity Market Reform – Progress and Remaining Challenges', in SIOSHANSI F. P. (ed.), *Competitive Electricity Markets: Design, Implementation, Performance*, Elsevier, The Netherlands 2008, p.19, 1-23.

to reliability compared to others.[17] Many institutions and scholars have attempted to define reliability. The North American Electric Reliability Corporation (NERC)[18] defines reliability as an electricity system that is "able to meet the electricity needs of end-use customers even when unexpected equipment failures or other factors reduce the amount of available electricity."[19] Further, The European Network of Transmission System Operators for Electricity (ENTSO-E) defines reliability as "the degree of performance of the elements of the bulk electric system that results in electricity being delivered to customers within accepted standards and in the amount desired."[20] Furthermore, the International Energy Agency (IEA) notes that:

> "Power system reliability is a very broad notion and is built around loads, generation and networks. At its simplest, it can be defined as 'keeping the lights on'. […] Reliability in this context encompasses the ability of the value chain to deliver electricity to all connected users within acceptable standards and in the amounts desired."[21]

All these well-respected international institutions mentioned above have agreed that reliability is an umbrella term that covers different dimensions from short to long term and different segments from transmission to generation.

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[17] NEWBERY D., 'Missing Money and Missing Markets: Reliability, Capacity Auctions and Interconnectors', July 2015, <http://www.eprg.group.cam.ac.uk/wp-content/uploads/2015/03/1508_updated-July-20151.pdf> accessed 12.11.2015, p.1.

[18] Representatives of the Electricity Utility Industry established NERC in 1968 in order to develop and promote the compliance with rules and protocols for the reliable function of the electricity transmission systems of North America. *See,* NERC, 'Frequently Asked Questions', August 2013, <http://www.nerc.com/AboutNERC/Documents/NERC%20FAQs%20AUG13.pdf>, accessed 12.11.2015, p.1.

[19] *ibid*., p. 1.

[20] ENTSO-E, 'Definitions and Acronyms', <https://emr.entsoe.eu/glossary/bin/view/GlossaryCode/GlossaryIndex>, accessed 12.11.2015.

[21] IEA, 'Secure and Efficient Electricity Supply: During the Transition to Low Carbon Power Systems', 2013, OECD, Paris, <https://www.iea.org/publications/freepublications/publication/SecureandEfficientElectricitySupply.pdf> accessed 25.02.2018, p.8.

Additionally, a number of scholars including Stoft,[22] Oren,[23] Cramton and Stoft,[24] Finon and Pignon,[25] Batlle and Perez-Arriaga,[26] Roques[27] and Batlle and Rodilla[28] have defined reliability in harmony with NERC, ENTSO-E and IEA. They also argued that the term reliability is an inclusive notion that consists of different components specified with different time dimensions. In a nutshell, it could be said that reliability describes the resiliency of an electricity market to cover aggregated electricity demand at a desired level at nearly all times. Below, the different dimensions of reliability as security, firmness and adequacy are dealt with.

2.2.1 Division of Reliability

2.2.1.1 Security

Security is the short-term component of the concept of reliability. As a very short term issue, basically security deals with real-time operation; that is, it can be seen as "the ability of the system to withstand sudden disturbances."[29] According to NERC and ENTSO-E, security is a notion that shows the strength of the electricity market against sudden and unexpected disturbances, such as short circuits or unexpected loss of system elements.[30] In the same vein, the IEA defines security as "capability of the power system, using existing resources, to

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[22] STOFT S., *Power System Economics: Designing Markets for Electricity*, IEEE Press, (2002), p.133.
[23] OREN S. S., 'Ensuring Generation Adequacy in Competitive Electricity Markets', 03.06.2003, <http://www.ieor.berkeley.edu/~oren/workingp/adequacy.pdf>, accessed 26.10.2015.
[24] CRAMTON P. and STOFT S., 'Forward reliability markets: Less risk, less market power, more efficiency', (2008), 16 *Utilities Policy* p.194, pp.194-201.
[25] FINON D. and PIGNON V., 'Electricity and long-term capacity adequacy: The quest for regulatory mechanism compatible with electricity market', (2008), 16 *Utilities Policy* p. 143-144, pp.143-158,
[26] BATLLE C. and PEREZ-ARRIAGA I.J., 'Design criteria for implementing a capacity mechanism in deregulated electricity markets', (2008), 16 *Utilities Policy* p. 184-185, pp.184-193.
[27] ROQUES F.A., 'Market design for generation adequacy: Healing causes rather than symptoms', (2008), 16 *Utilities Policy* p.172, pp.171-183.
[28] BATLLE C. and RODILLA P., 'A critical Assessment of the Different Approaches Aimed to Secure Electricity Generation Supply', (2010), 38 *Energy Policy* p.7169-7170, pp. 7169-7179.
[29] JACOBSEN H. K. and JENSEN S. G., 'Security of Supply in Electricity Markets: Improving Cost Efficiency of Supplying Security and Possible Welfare Gains', (2012), 43/1 *International Journal of Electrical Power & Energy Systems* 680 687, p. 681.
[30] See, NERC, 'Frequently Asked Questions', *Supra* note 18 and ENTSO-E, 'Definitions and Acronyms', *Supra* note 20.

maintain reliable supplies in the face of unexpected shocks and sudden disruptions, e.g. the loss of key generation or network components or rapid changes in demand."[31] Security is provided by TSOs in real time through operating reserves supplied by generators.[32] These operating reserves come into play when supply is hard put to meet demand. This may happen especially during peak demand time if the difference between supply and demand, called as reserve margin, is tight.

2.2.1.2 Firmness

Firmness is a short to medium term issue and can be defined as "the ability of the already installed facilities to supply electricity efficiently."[33] This means that, even with redundant generation capacity during peak demand, if the significant part of this capacity is unavailable due to different reasons such as lack of water in the reservoirs or out-of-service plants for maintenance or forced outage hours or lack of fuel in the tanks, demand and supply may not be balanced in an efficient way.[34] Within the context of firmness, fuel security is related to preserving security of fuel supply for electricity generation against a background of changing conditions in international commodity markets, developments in upstream sectors and security of existing and new supply routes.[35]

2.2.1.3 Adequacy

Adequacy is a long-term component of the concept of reliability. NERC defines adequacy as "having sufficient resources to provide customers with a continuous supply of electricity at the proper voltage and frequency, virtually all of the time."[36] In the same vein, ENTSO-E

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[31] IEA, 'Secure and Efficient Electricity Supply: During the Transition to Low Carbon Power Systems', *Supra* note 21.
[32] STOFT S., *Power System Economics: Designing Markets for Electricity, Supra* note 22, p.135.
[33] BATLLE C. and RODILLA P., 'A critical Assessment Of The Different Approaches Aimed To Secure Electricity Generation Supply', *Supra* note 28, p.7170.
[34] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets' in PEREZ-ARRIAGA I.J. (ed.), *Regulation of the Power Sector*, Springer, London, 2013, p. 586, 581-622.
[35] IEA, 'Secure and Efficient Electricity Supply: During the Transition to Low Carbon Power Systems', *Supra* note 21, p. 8.
[36] See NERC, 'Frequently Asked Questions', *Supra* note 18.

describes adequacy as the ability of the electricity market to meet the aggregated demand of customers at all times by considering scheduled and unscheduled but reasonably expected outages of electricity system elements.[37] According to the IEA, adequacy refers to the ability of the electricity market to meet aggregated electricity demand by using existing and new resources in the present and future.[38] The IEA also attracts the attention to the importance of timely and flexible investment and demand-side responses.

Adequacy can be divided into two sub-categories: Network adequacy and generation adequacy.

2.2.1.3.1 Network Adequacy

The electricity market is a network-bound market. Hence, reliability does not only depend upon the generation adequacy, but sufficient transmission and distribution lines are also critical.[39] In this sense, network adequacy can be defined as "the ability of a power system to manage the flow resulting from the transfer of power from generation to the consumption centre."[40]

2.2.1.3.2 Generation adequacy[41]

NERC defines generation adequacy as "[t]he ability of supply-side and demand-side resources to meet the aggregate electrical demand (including losses)."[42] Pfeifenberger defines

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[37] See ENTSO-E, 'Definitions and Acronyms', *Supra* note 20.

[38] See IEA, 'Secure and Efficient Electricity Supply: During the Transition to Low Carbon Power Systems', *Supra* note 21, p.8.

[39] KEAY M., 'Can the Market Deliver Security and Environmental Protection in Electricity Generation?', in RUTLEDGE I. and WRIGHT P. (eds), *UK Energy Policy and the End of Market Fundamentals*, The Oxford Institute for Energy Studies, The Oxford University Press, 2010, p.286-289, pp.281-308.

[40] European Commission, 'Identification of Appropriate Generation and System Adequacy Standards for the Internal Electricity Market', Final Report, 20.03.2016, <https://ec.europa.eu/energy/sites/ener/files/documents/Generation%20adequacy%20Final%20Report_for%20publication.pdf>, accessed 25.02.2018, p. 25. As a further information, the Commission in its document used here employs the term "transmission adequacy" instead of "network adequacy". However, it can be understood that both of these terms can be used interchangeably.

[41] In literature, the terms "generation adequacy" and "resource adequacy" are used interchangeably. It should be kept in mind that both express the same concept.

[42] NERC, 'Glossary of Terms Used in NERC Reliability Standards', <http://www.nerc.com/files/glossary_of_terms.pdf>, accessed 30.09.2017.

generation adequacy as “ability to supply load with adequate generation resources.”[43] Generation adequacy can be measured using different techniques such as capacity margin and LOLP (Loss of Load Probability)/LOLE (Loss of Load Expectation).[44] Capacity margin refers to the percentage difference between expected maximum available capacity and expected peak demand.[45] For instance, a 15% reserve margin means that the said electricity market has 15% more capacity (excess capacity) than expected peak demand.[46] It is a measure employed by TSOs to monitor the supply situation to meet demand.[47] LOLP is a measure used to calculate the probability of a given level of unmet demand, which is expressed as a percentage of time where demand will not be met, for instance, for 1 day in 10 years some consumers would not have access to electricity.[48]

2.2.1.3.2.1 Flexibility as an Essential Component of Generation Adequacy

The revolutionary transformation in electricity markets witnessed in the last decade has made *flexibility* the essential part of the definition of generation adequacy. With increasing intermittent RESs in electricity markets, the issue of flexibility has been regarded as a problem to ensure generation adequacy. A number of scholars including Haas et al.[49] Ela et al.[50] and

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[43] PFEIFENBERGER H., ‘Resource Adequacy Requirements, Scarcity Pricing, and Electricity Market Design Implications’, Presented to IEA Electricity Security Advisory Panel (ESAP), The Brattle Group, 02.07.2014, <https://www.iea.org/media/workshops/2014/esapworskhopi/Hannes_Pfeifenberger.pdf> accessed 30.09.2017.

[44] European Commission, ‘Assessing Generation Adequacy and the Necessity of Capacity Mechanisms’, Capacity Mechanisms Working Group, 22 January 2015, <http://ec.europa.eu/competition/sectors/energy/capacity_mechanisms_working_group_1.pdf>, accessed 25.02.2018, pp. 3-4.

[45] US Energy Information Administration (EIA), ‘Reserve electric generating capacity helps keep the lights on’, 01.06.2012, <http://www.eia.gov/todayinenergy/detail.cfm?id=6510> accessed 18.11.2015.

[46] *ibid*.

[47] *ibid*.

[48] European Commission, ‘Assessing Generation Adequacy and the Necessity of Capacity Mechanisms’, *Supra* note 44, p. 4.

[49] HAAS R. et al, ‘The Growing Impact of Renewable Energy in European Electricity Markets’, in SIOSHANSI F.P. (ed.), *Evolution of Global Electricity Markets: New Paradigms, New Challenges, New Approaches*, (2013), Academic Press, pp. 131-132, pp.125-146.

[50] ELA E. et al., ‘Evolution of Wholesale Electricity Market Design with Increasing Levels of Renewable Generation’, September 2014, <https://www.nrel.gov/docs/fy14osti/61765.pdf> accessed 30.09.2017.

Henriot[51] have rightly indicated that increasing intermittent RES within generation mixes around the world simultaneously increases the need for *flexibility* which is properly supplied by conventional generators, particularly natural gas power plants, and well-designed demand-side response programmes. The increasing need for *flexibility* is fundamentally related to the intermittency problem of, particularly, wind and solar power. Intermittency problem stem from three basic characteristics of these resources: (1) Intermittent RESs are variable because their electricity output depends on weather conditions; (2) Supply of RESs are uncertain because their electricity output is unclear until the real time; and (3) These intermittent RESs are location-specific because the potential of wind and solar power are not technically necessary to be situated close to demand centres.[52] So, with these characteristics, integrating intermittent RESs into electricity markets requires more flexible electricity systems.

Generators can be categorized in terms of their generation capacity and *flexibility*. On the one hand, generation capacity basically means the maximum electricity that a generator can produce.[53] On the other hand, a generator can be regarded as flexible if it can adapt its electricity generation in line with the rapid change in electricity demand and the production level of intermittent RESs.[54] In this sense, while some types of generators such as nuclear power plants can be regarded as suitable for generating a stable amount of electricity over a long period of time with nearly zero flexibility, others such as gas power and hydropower plants can rapidly adapt (so, with high flexibility) their levels of generation to fluctuations in electricity demand and variable generations of intermittent RESs.[55] Within this content, the *flexibility* term can be defined as "the ability of a system to deploy its resources to respond to

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[51] HENRIOT A., 'Economics of intermittent renewable energy sources: four essays on large-scale integration into European power systems', 2014, Université Paris Sud, Paris, PhD Thesis, <https://tel.archives-ouvertes.fr/tel-01128060/document> accessed 30.09.2017.

[52] KONDZIELLA H. and BRUCKNER T., 'Flexibility requirements of renewable energy based electricity systems – a review of research results and methodologies', 2016, 53 *Renewable and Sustainable Energy Reviews* 10-22, p.11.

[53] European Parliament, 'Capacity mechanisms for electricity', Briefing, May 2017, <http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/603949/EPRS_BRI(2017)603949_EN.pdf> accessed 25.02.2018, p. 2.

[54] *Ibid.*

[55] *Ibid.*

changes in net load, where net load is defined as the remaining system load not served by variable generation."[56]

The enormous growth in intermittent RESs capacity makes it necessary to take account of the need for increased *flexibility* when defining generation adequacy. Indeed, as noted by Henriot and Glachant:

> "[…], a large share of the resources remunerated will have to operate in a flexible way, so as to cope with the variability of intermittent RES. In this context, generation adequacy […] is not only about securing a minimum reserve margin, but also about delivering an adequate flexibility mix for the system. Part of the incentives to promote generation flexibility […] might be embodied in short-term energy prices, but it is clear that the issue of generation adequacy cannot be completely separated from the issue of flexibility."[57]

2.3 Summary

The dimensions of reliability analysed above are inherently related to each other. That is, the absence of any of the mentioned dimensions makes the existence of the other dimensions meaningless. The Commission indicated on this issue that:

> "Security and adequacy are closely related notions but are not identical. Without system security, the output of the generation resources, no matter how abundant they may be, cannot be delivered to customers. Correspondingly, a high degree of

[56] LANNOYE E. et al., 'Evaluation of Power System Flexibility', <http://energyexemplar.com/wp-content/uploads/publications/Journal_REVIEW%202_Eamonn%20Lannoye.pdf> accessed 28.09.2017, p.1.
[57] HENRIOT A. and GLACHANT J.M., 'Capacity Mechanisms in the European Market: Now, but How?', in HANCHER L. et al (eds), *Capacity Mechanisms in the EU Energy Market: Law, Policy and Economics,* Oxford University Press, UK, 2015, p.40.

security is of little value if there are insufficient generation and transmission resources to meet customer needs."[58]

Therefore, a holistic approach to the reliability of electricity supply is required to establish a well-functioning electricity market. Nevertheless, such a classification discussed above is necessary in order to grasp the issue of the reliable supply of electricity more clearly. Within the context of this thesis, generation adequacy as the relevant concept of this thesis will be discussed throughout this study. For this reason, it is important to show how and to what extent generation adequacy and others are separated. Table 2 contains a brief summary of the conceptual classification of reliability studied above.

Table 2 Classification of Reliability of Electricity Supply[59]

<table>
<tr><th>Umbrella Term</th><th>Classification</th><th colspan="2">Definitions</th></tr>
<tr><td rowspan="4">Reliability</td><td>Security</td><td colspan="2">Security is the short-term component of the concept of reliability. It shows the endurance of an electricity system to any unexpected shocks and sudden disruptions.</td></tr>
<tr><td>Firmness</td><td colspan="2">Firmness is a concept that cover the mid to long term. It basically deals with the supply of already installed generation capacity efficiently.</td></tr>
<tr><td rowspan="2">Adequacy</td><td>Generation Adequacy</td><td>The ability of resources including both supply and demand side resources to meet total demand in the long-term. With an increasing share of intermittent RESs in the generation mix, flexibility as the new component of the definition of generation adequacy has become prominent in recent years. Flexibility, in short, is the ability of an electricity system to meet in electricity demand and variable electricity generations of RESs.</td></tr>
<tr><td>Network Adequacy</td><td>Electricity markets are network-bound markets. Therefore, reliability is not only related to adequate generation capacity but adequate levels of network investment is also vital so as to reach electricity from production points to consumption points. With this understanding, network adequacy can be defined as the ability of an electricity system</td></tr>
</table>

[58] European Commission, 'Identification of Appropriate Generation and System Adequacy Standards for the Internal Electricity Market', *Supra* note 40, p.24.
[59] Prepared by the author based on discussions made above.

			that can ensure electricity from generators to consumers through adequate network capacity.

3. Generation Adequacy in Energy-only Electricity Markets: Why is It a Problem?

Since the first liberalisation of electricity market in Chile in 1982, the question of whether energy-only markets can ensure generation adequacy with its own devices have been asked.[60] For instance, the IEA noted as early as 2000 that:

> "[i]n the case of security of supply, market decisions may be expected to reflect adequately the short-term cost of security. However, the impact of market liberalisation on investments in long term generating capacity and diversity of fuel inputs to power generators is not yet fully clear."[61]

However, this question was overlooked by many countries around the world based on confidence in the market mechanism. A very well-known fact, in early electricity market models after liberalisation the role of the market was emphasised to the extent that even generation investment decisions were left to the market.[62] Liberalisation created an assumption that electricity, as an ordinary commodity, could be traded unfailingly in a normal market-place. For instance, Nigel Lawson, as the UK Secretary of State for Energy in 1982, labelled the new era as "The Market for Energy" in his speech.[63] It was assumed that energy-only markets could provide adequate levels of electricity capacity to ensure security of supply at any time. As rightly noted by Finon and Pignon, the electricity market model with liberalisation (energy-only market) was anticipated to create an ideal level of reliability in accordance with an instantaneous price-elastic demand function, which yielded a price

[60] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34, p.584.
[61] IEA, 'Electricity Market Reform: An IEA Handbook', OECD/IEA, Paris, 1999, <http://abraceel.com.br/_anexos/mreform99.pdf> accessed 15.02.2018, p. 97-98.
[62] DOW S., 'Energy Policy and Energy Strategy', Unpublished Lecture Notes for Downstream Energy Law and Policy, University of Dundee, CEPMLP, p.11.
[63] FELLS I. and WHITMILL C., 'A Pragmatic Energy Policy for the UK', *Supra* note 4, p.10.

quantity equilibrium by capturing consumers' separated demand for reliability and supply.[64] This rainbows-and-unicorns approach could be thought as a consequence of initial overcapacity prior to liberalisation.[65] Additionally, policy makers had time to build reliability for the market without suffering from high pressure to ensure a balance between supply and demand.[66] Hence, the question of whether energy-only markets have enough incentives to attract new investments in generations was not that much of an issue at the beginning of liberalisation, especially in European countries.[67] However, this has been changing following rising demand, the gradual retirement of older plants and new investments becoming progressively risky owing to high price volatility and the shortage of a regulatory framework for stable markets.[68] This critical question gained importance in the 2000s as international experiences showed that energy-only markets have also created challenges and crises for ensuring generation adequacy. The first failure was the very well-known Californian electricity crises occurred in 2001. It is a typical case that shows how badly deregulated and designed electricity markets can result in particularly large economic disruptions. Electricity blackouts in California lasted only 30 hours in total (spread over 6 days) and around 2% of the total demand was interrupted, but the economic damage of this crisis was between $40-45 billion, around 3.5% of the yearly total economic output of California.[69]

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64 FINON D. and PIGNON V., 'Electricity and Long-Term Capacity Adequacy: The Quest for Regulatory Mechanism Compatible with Electricity Market', *Supra* note 25, p. 144.

65 IEA, 'Energy Market Experience: Lessons from Liberalised Electricity Markets', 2005, OECD, Paris, <https://www.iea.org/publications/freepublications/publication/LessonsNet.pdf> accessed 15.02.2017, p.117.

66 *ibid*.

67 CRAMTON P. and OCKENFELS A., 'Economics and design of capacity markets for the power sector', 30.05.2011, <ftp://www.cramton.umd.edu/papers2010-2014/cramton-ockenfels-economics-and-design-of-capacity-markets.pdf> accessed 19.10.2017, p.4.

68 *ibid*.

69 HAWKINS D., 'The California Report', Power Point Presentation, California ISO, cited in DE VRIES L. J. and HAKVOORT R.A., 'The question of generation adequacy in liberalised electricity markets', <https://www.ecn.nl/fileadmin/ecn/units/bs/INDES/indes-ldv_paper.pdf> accessed 19.10.2017 and WEARE C., 'The California Electricity Crisis: Causes and Policy Options', Public Policy Institute of California, 2003, <http://www.ppic.org/content/pubs/report/R_103CWR.pdf> accessed 19.10.2017, pp.3-4.

Researchers such as Joskow,[70] Ford,[71] Weare,[72] Wolak[73] and Bushnell[74] wrote about the Californian case from different perspectives. According to their research, the causes of the California electricity crisis can be listed as follows: Shortage of generating capacity, market power abuse, boom-and-bust cycle problem, lack of long-term contracts and market design problems. Naturally, these reasons were not just valid for the Californian electricity market. Many electricity markets around the world have suffered from similar challenges following liberalisation. In 2003, wide-scale power outages hit North America, Italy and Scandinavian countries.[75] Later, similar disruptions severely affected many European electricity markets in 2006.[76] When the underlying causes of these power failures were examined, it was concluded that there were many resemblances among the events occurred in different countries.[77] It was understood that the basic principles of reliable supply of electricity must had been adapted to the new conditions introduced by liberalisation, which is particularly vital for electricity markets where cross-border power trade has larger role.[78] With this understanding, the US developed a range of regulatory measures within the legal framework of the Energy Policy Act 2005 and made reliability criteria legally binding for SOs.[79] The current struggle for the reshaping of the European electricity markets should be perceived in this frame.

Before liberalisation, there was virtually no concern regarding who will ensure generation adequacy in electricity markets. In a vertically integrated electricity market structure, security of supply was monitored via centralised planning. Hence, there was no need to deal with dimensions mentioned above separately and there was no requirement to think about the issue of responsibility. Liberalisation, nonetheless, has brought about a new challenge

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[70] JOSKOW P. L., 'California's Electricity Crisis', (2001), 17 *Oxford Review of Economic Policy* 365-388.
[71] FORD A., 'Boom and Bust in Power Plant Construction: Lessons from the California Electricity Crisis', (2002), 2 *Journal of Industry, Competition and Trade* 59-74.
[72] WEARE C., 'The California Electricity Crisis: Causes and Policy Options', *Supra* note 69.
[73] WOLAK F.A., 'Diagnosing the California Electricity Crisis', (2003), 16 *The Electricity Journal* 11-37.
[74] BUSHNELL J., 'California's electricity crisis: a market apart?', (2004), 32 *Energy Policy* 1045-1052.
[75] IEA, 'Tackling Investment Challenges in Power Generation: In IEA Countries', (2007), OECD, Paris, <https://www.iea.org/publications/freepublications/publication/tackling_investment.pdf> accessed 25.02.2015, p.33.
[76] *ibid*.
[77] *ibid*.
[78] *ibid*, p.34.
[79] *ibid*, p.34.

regarding the ability of markets to ensure long-term resource adequacy. As the process of liberalisation have continued, responsibility between states and markets regarding generation adequacy have become gradually vague.[80] A significant number of scholars including Besser et al.[81] De Vries and .,[82] Joskow,[83] De Vries,[84] Finon and Pignon,[85] Ausubel

[80] Cameron and, Suater and Schepel discussed how the responsibility between states and markets have been evolved with liberalisation in energy markets. In this regard, definition of security of supply has been considerably changed in the context of liberalised electricity markets and gains multifaceted notion. It has needed to be redefined in line with the new concept. Many researchers, in this sense, define the security of supply with a risk-based approach. Egenhofer et al., for instance, highlighted accurately the changing roles of governments, companies and consumers in liberalised energy markets concerning security of supply. They suggested that the definition of supply security should be reviewed with regards to risk and associated costs. Lieb-Docyz et al. also said that "security of supply is fundamentally about risk. More secure systems are those with lower risks of system interruption." Accordingly, Jamasb and Pollitt emphasized the price risk of energy resources that may lead to security of supply risk. They indicated that "security of supply becomes a risk-management strategy with a strong inclination towards cost effectiveness, involving both the supply and the demand side." In addition to these definitions, a range of other researchers such as Rutherford et al., Scheepers et al. and Wright approached security of supply in terms of risk-management. The following resources for this discussion: *See,* CAMERON P.D., *Competition in Energy Markets: Law and Regulation in the European Union*, Oxford University Press, New York, 2007, pp. 19-21; SAUTER W. and SCHEPEL H., *State and Market in European Law: The Public and Private Spheres of the Internal Market before the EU Courts,* Cambridge University Press, Cambridge/UK, 2009, p. 19; JAMASB T. and POLLITT M., 'Security of supply and regulation of networks', (2008), 36 *Energy Policy* 4584-4589, p.4584; EGENHOFER C. et al*,* 'Market-based options for Security of Energy Supply', September 2004, <http://host.uniroma3.it/dipartimenti/economia/pdf/FEEM_117-04.pdf> accessed 18.02.2013; LIEB-DOCZY E. et al, 'Who Secures the Security of Supply? European perspectives on security, competition, and liability', (2003), 16 *Electricity Journal* 10-19, p.11; RUTHERFOLD J.P. et al, 'Linking consumer energy efficiency with security of supply', (2007), 35 *Energy Policy* 3025-3035, p.326; SCHEEPERS M., 'EU Standards for Security of Supply', June 2006, <http://www.ecn.nl/docs/library/report/2006/c06039.pdf> accessed 16.02.2013, p.13; WRIGHT P., 'Liberalisation and the security of gas supply in the UK', (2005), 33 *Energy Policy* 2272-2290.

[81] BESSER J.G., FARR J. G. and TIERNEY S. F., 'The Political Economy of Long-Term Generation Adequacy: Why an Icap Mechanism Is Needed as Part of Standard Market Design', (2002), 25 *The Electricity Journal*, pp. 53-62.

[82] DE VRIES L.J. and HAKVOORT R.A., 'The question of generation adequacy in liberalised electricity markets', *Supra* note 69.

[83] JOSKOW P.L., 'Competitive Electricity Markets and Investment in New Generating Capacity', 12.06.2006, <http://economics.mit.edu/files/1190> accessed 09.11.2013 and JOSKOW P. L., 'Capacity Payments in Imperfect Electricity Markets: Need and Design', (2008), 16 *Utilities Policy* 159-70.

[84] DE VRIES L., 'Generation Adequacy: Helping the Market Do Its Job', (2007), 15 *Utilities Policy* pp. 20-35.

[85] FINON D. and PIGNON V., 'Electricity and long-term capacity adequacy: The quest for regulatory mechanism compatible with electricity market', *Supra* note 25.

and Cramton[86] and Rodilla and Battle[87] analysed this issue. All of them, more or less, agreed that several market imperfections which characteristically pertain to electricity markets prevent energy-only markets from providing sufficient generation adequacy. These market imperfections can be summarised as missing money problem, market power and entry barriers, boom and bust cycle problem, lack of long-term contracts and inelastic demand structure. In addition to the economics-based realities mentioned above, Besser *et al* call attention to the political economic dimension of electricity markets and notes that "[u]nfortunately, given the level of effort that has been expended, the question of the need for, desirability, and/or appropriateness of capacity obligation as a separate element of a competitive electricity market cannot be answered solely through economic theory."[88] It is a well-known fact that electricity as a public utility is not generally seen as a standard commodity or service, because a dramatic price rise or a sudden blackout or other failures in electricity markets can adversely affect the political position of politicians, unsurprisingly more than for other sectors. On this point, Rodilla and Batlle rightly draw attention to politicians' risk aversion regarding electricity markets in which any shortage of electricity, as an essential good may have significant social and political outcomes.[89]

As can be seen from the discussion so far, concerns regarding generation adequacy have existed since electricity markets liberalised. These concerns have been fuelled by many electricity crises as noted above. The imperfections that caused these crises should be individually analysed to understand why energy-only markets may not ensure generation adequacy without regulatory intervention. However, before discussing the imperfections that prevent the proper functioning of electricity markets, it is appropriate to briefly examine what the theory suggests for energy-only markets concerning the ability regarding generation adequacy.

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[86] AUSUBEL L. M. and CRAMTON P., 'Using Forward Markets to Improve Electricity Market Design', (2010), 18 *Utilities Policy* pp.195-200.

[87] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34.

[88] BESSER J.G., FARR J. G. and TIERNEY S. F., 'The Political Economy of Long-Term Generation Adequacy: Why an Icap Mechanism Is Needed as Part of Standard Market Design', *Supra* note 81, pp. 53-54.

[89] RODILLA P. and BATLLE C., 'Security of Electricity Supply at the Generation Level: Problem Analysis', (2012), 40 *Energy Policy* 177-185, p. 182.

3.1 Energy-only Markets: What does Theory Suggest?

The only revenue source for cost recovery in energy-only markets is the difference between the price determined by the market and the generating cost of electricity.[90] In a perfectly competitive electricity market, since electricity prices differ constantly to follow the supply and demand positions at any time, the payment above the system marginal cost should cover the capacity costs.[91] Economic theory states that electricity prices in energy-only markets showing short-term supply and demand status provide sufficient market signals for a proper generation capacity need.[92] Researchers have proved that, in theory, energy-only electricity markets should provide adequate incentives to attract enough capacity for generation adequacy.[93] This idea is actually based on 'spot pricing theory' developed by Caramanis and Caramanis et al.[94] Caramanis defined spot prices as prices which vary in process of time in accordance with the conditions of the electricity market.[95] According to Caramanis, "spot pricing is an instrument which dampens the impact of investment planning shortfalls and ameliorates society`s costs resulting from erroneous forecasts of demand and other uncertain variables."[96] Joskow also showed that under ideal conditions, energy-only markets can provide adequate revenues for base, intermediate and peak generators through scarcity pricing.[97] According to Hirst and Hadley, generation adequacy can be ensured in two ways: 1-

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[90] WEN F.S., WU F.F. and NI Y.X., 'Generation capacity adequacy in the competitive electricity market environment', (2004), 26 *Electrical Power and Energy Systems* 365-372, p. 366.
[91] *ibid*.
[92] *ibid*.
[93] CARAMANIS M., 'Investment Decisions and Long-term Planning Under Electricity Spot Pricing', (1982), PAS-101 *EEE Transaction on Power Apparatus and Systems* 4640-4648; HIRST E. and HADLEY S., 'Maintaining Generation Adequacy in a Restructuring U.S. Electricity Industry', October 1999, <https://digital.library.unt.edu/ark:/67531/metadc628266/m2/1/high_res_d/15044.pdf> accessed 25.02.2018; STOFT S., *Power System Economics: Designing markets for Electricity*, *Supra* note 22; JOSKOW P. and TIROLE J., 'Reliability and competitive electricity markets', (2007), 38 RAND *Journal of Economics* 60-84; VENTOSA M. et al, 'Power System Economics' in PEREZ-ARRIAGA I.J. (ed.), *Regulation of the Power Sector*, Springer, London 2013, pp.47-124, p.82-83.
[94] CARAMANIS M., 'Investment Decisions and Long-term Planning Under Electricity Spot Pricing', *Supra* note 93; CARAMANIS M. et al, 'Optimal Spot Pricing: Practice and Theory', (1982), PAS-101 *EEE Transaction on Power Apparatus and Systems* 3234-3245.
[95] CARAMANIS M., 'Investment Decisions and Long-term Planning Under Electricity Spot Pricing', *Supra* note 93, p. 4640.
[96] *ibid*, p. 4643.
[97] JOSKOW P.L., 'Capacity Payments in Imperfect Electricity Markets: Need and Design', *Supra* note 83, pp. 10-14.

sole reliance upon the market with a spot-pricing mechanism; 2- continuing historical method by setting some requirements on installed capacity that have to be met by all market players.[98] Hirst and Hadley claim that the former option will be preferred more than the latter.[99] Further, De Vries and Hakvoort indicate that according to this school of thought, lack of investment would be induced by impediments to the proper mechanism of the market, such as construction permits or price restrictions.[100]

As indicated by Hunt, a competitive market requires many sellers as well as many buyers who are able to respond to price.[101] These kinds of markets called *well-functioning market* are constantly reliable since consumers are always aware how much/many they can consume with a given price.[102] As stated above, this is directly related to pricing mechanisms. Although billions of individuals around the world can buy thousands of commodities in accordance with a pricing mechanism, this mechanism to a large extent does not work in electricity markets. Consumers buy electricity whenever they switch the lights on without checking the price first or negotiating for lower price.[103] Hence, in real life, electricity consumers most of the time cannot adjust their consumptions according to a pricing mechanism. The reason why electricity markets do not work like other markets is due to several imperfections that are analysed below.

3.2 Imperfections of Energy-only Markets: Gaps between Promise and Reality

3.2.1 Reliability as a Public Good

The first imperfection of energy-only markets focuses on the public good characteristic of reliability of electricity supply. Economic theory defines public goods as goods that, once

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[98] HIRST E. and HADLEY S., 'Generation Adequacy: Who Decides?', (1999), 12 *The Electricity Journal* 11-21, p.21

[99] ibid.

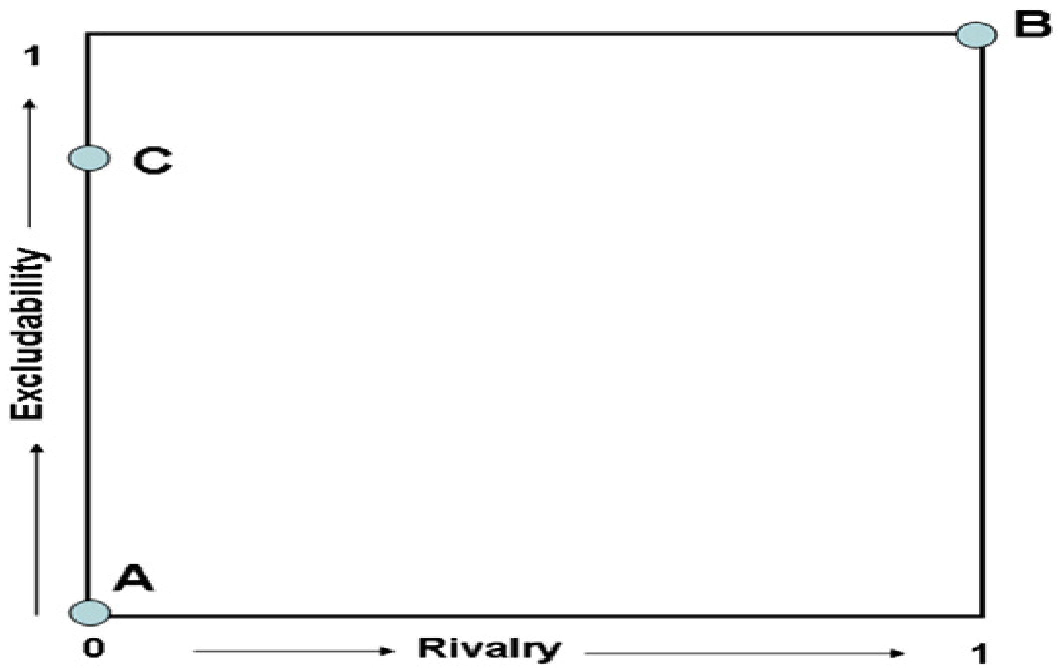
[100] DE VRIES L.J. and HAKVOORT R.A., 'The question of generation adequacy in liberalised electricity markets', *Supra* note 69.

[101] HUNT S., *Making Competition Work in Electricity Market*, Published by John Wiley & Sons, New York, 2002, p.71.

[102] *ibid*, pp. 75-76.

[103] *ibid*, p.74.

produced, can be consumed by an extra consumer at no extra cost.[104] As a second characteristic of public goods, non-excludability is sometimes shown; that is, no consumer can be excluded from consuming the public goods once they are produced.[105] Public Goods Theory was originally developed by Samuelson who divided goods into two categories: private consumption goods and collective consumption goods.[106] According to Samuelson, a public consumption good such as national defence or an out-door circus is provided for each person jointly.[107] In light of this knowledge, economists accept goods (or services) as public good if after producing they are accessible to all consumers and cannot be retained from even one individual without retaining them from all.[108] Henceforth, public goods are regarded to have the features of being non-exclusive and non-rival (See Figure 3).[109]



[104] HOLCOMBE R.G., 'A Theory of the Theory of Public Goods', (1997), 10 *Review of Austrian Economics* 1-22, p.1.
[105] *ibid*.
[106] SAMUELSON P.A., 'The pure theory of public expenditure', (1954), 36 *Review of Economics and Statistics* 387-389.
[107] SAMUELSON P.A., 'A diagrammatic exposition of a theory of public expenditure', (1955), 37 *Review of Economics and Statistics* 350-356, p. 350.
[108] ABBOTT M. , 'Is the Security of Electricity Supply a Public Good?', (2001), 14 *The Electricity Journal* 31-33, p.32.
[109] *ibid*.

Figure 3: Classifying goods according to the degree of rivalry and excludability: (A) Pure public good, (B) Pure private good, and (C) Non-rival good.[110]

However, it is not always easy to understand whether a good or service is a public good or not. Furthermore, some claim that the definition of public goods and, in this context, public interest should be changed after the major amendment in traditional public goods such as water, transport, energy, communications and healthcare.[111] For instance, there is still ongoing debate regarding the reliability of electricity supply. While somebody regards it as a pure-public good, others do not.[112] Herein, a critical division should be made between electricity as a tradable commodity and its reliable supply (capacity). In this study, it is assumed that reliability of electricity supply is a public good rather than electricity itself. Many researchers including Stoft,[113] Joskow,[114] Finon et al[115] and Finon and Pignon[116] regard reliability of electricity supply as a public good. For instance, Finon and Pignon noted that:

> "Capacity adequacy – which could also be termed long-term security – is a public good since it is non-rival and non-excludable. This good is non-rival, since everybody benefits from the security provided to the system by new facilities provided by anyone […] This is a non-excludable good since, as we shall see, it is impossible to personalize contractual arrangements governing long-term provision with respect to the preference of each consumer for supply reliability and their willing to pay."[117]

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[110] JACOBSEN H. K. and JENSEN S. G., 'Security of Supply in Electricity Markets: Improving Cost Efficiency of Supplying Security and Possible Welfare Gains', *Supra* note 29, p.681.
[111] SAUTER W. and SCHEPEL H., *State and Market in European Law: The Public and Private Spheres of the Internal Market before the EU Courts,* Cambridge University Press, Cambridge/UK, 2009, p.20.
[112] JACOBSEN H. K. and JENSEN S. G., 'Security of Supply in Electricity Markets: Improving Cost Efficiency of Supplying Security and Possible Welfare Gains', *Supra* note 29, p.681.
[113] STOFT S., *Power System Economics: Designing Markets for Electricity*, *Supra* note 22, p. 86.
[114] JOSKOW P.L., 'Competitive Electricity Markets and Investment in New Generating Capacity', *Supra* note 83, p.8.
[115] FINON D., MEUNİER G. and PIGNON V., 'The social efficiency of long-term capacity reserve mechanisms', (2008), 16 *Utilities Policy* 202-214, p. 212.
[116] FINON D. and PIGNON V., 'Electricity and long-term capacity adequacy: The quest for regulatory mechanism compatible with electricity market', *Supra* note 25.
[117] *ibid*.

The practical outcome of being public for reliability of electricity supply is that a market mechanism cannot provide a public good at the required level. This is a typical market failure caused by the public good characteristic of reliability of electricity supply. Therefore, as can be seen in other types of market failure, a level of government intervention is required in order to fix this market failure in energy-only markets.

3.2.2 The Missing Money Problem

The missing money problem[118] is caused by the fact that spot prices in electricity markets do not increase sufficiently throughout times of scarcity to provide adequate revenue to cover investment costs. [119] Figure 4 below shows the areas where base-load, mid-range and peak generators can make a return on their investment. The only area that peak generators can make a return on their investments is at Area A. However, as shown in Figure 5, peak generators cannot bear their costs because of price-cap regulation.

Figure 4 Market Price and Risk-aversion of Peak-time Plants[120]

[118] The missing money problem is not only a challenge for capacity constrained electricity markets such as most of the European power markets or electricity markets driven by intermittent RESs, but it is also a real problem for energy constrained electricity markets such as Brazil electricity market which is mainly dominated by hydropower plants. For the discussion about how the missing money problem affects the hydro-dominated electricity markets. *See,* LOSEKANN L. et al, ‘Security of supply in large hydropower systems: the Brazilian case’, in EVANS J. and HUNT L.C. (eds.), *International Handbook on the Economics of Energy,* Edward Elgar Publishing Limited, UK, 2009, pp. 650-662.

[119] HOGAN W.W., 'On an "Energy Only" Electricity Market Design for Resource Adequacy', 23.09.2005, <http://www.hks.harvard.edu/fs/whogan/Hogan_Energy_Only_092305.pdf>, accessed 04.11.2013, p. 2-7; JOSKOW P.L., 'Competitive Electricity Markets and Investment in New Generating Capacity', *Supra* note 83.

[120] HOGAN W.W., 'On an "Energy Only" Electricity Market Design for Resource Adequacy', *Supra* note 119, p.3.

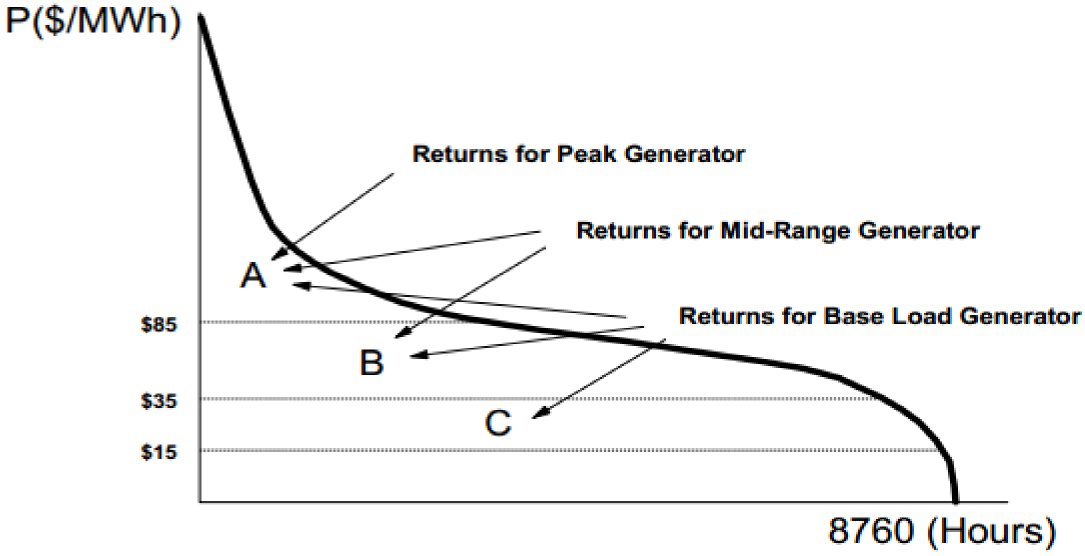
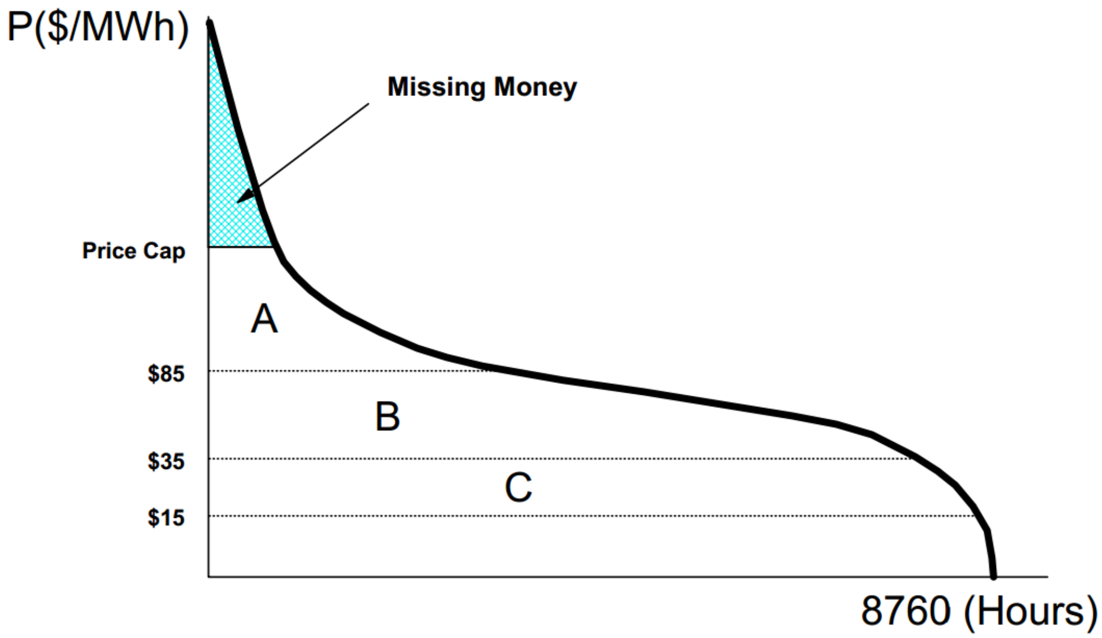


Figure 5 The Missing Money Problem[121]



Actually, price-cap regulation itself is not a wrong policy as it directly protects consumers from unacceptably high prices, which can be a result of possible market power abuses during times of scarcity. Market power may be described as possessing the capability by a seller, or a group

[121] *ibid*, p.4.

of sellers, to manage prices over a competitive level and drive the total production or eliminate competitors from a relevant market for significant periods of time.[122] It decreases quality, competitiveness and innovation for technology,[123] which are the main aims of the deregulation of electricity markets. Electricity markets are structurally very prone to exercises of market power, since they are very suitable for creating an oligopolistic market.[124] It has long been known that electricity markets, compared to other industries, are particularly open to market power abuse owing to several reasons including: transmission constraints that limit the geographic spread of competition; concentration in generation ownership with limited import potential; the low price elasticity of electricity; and the non-storability of electricity.[125] For instance, following liberalisation in the EU electricity markets, a considerable part of wholesale electricity markets have continued to be national-based and have displayed a significant concentration in generation market, which gives room for the market power exercise.[126] Principally, without entry barriers, the oligopolistic behaviours should not be a matter at all, as new companies would not experience any difficulty for entry.[127] However, the fundamental problem is that the entry barriers to market stemmed from the inherent problem of electricity markets owing to the existence of high capital investment and sunk costs.[128]

Because of the abovementioned peculiar characteristics of electricity markets, governments or regulatory authorities cannot easily understand whether a price movement in electricity markets is reflecting scarcity or is a result of market power abuse.[129] In this sense, Roques et

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[122] KARTHIKEYAN S.P., RAGLEND I.J. and KOTHARI D.P., 'A review on market power in deregulated electricity market', (2013), 48 *Electrical Power and Energy Systems* 139-147, p.139.
[123] *ibid*.
[124] RIGACCI C.G., 'What objectives can be achieved through electricity supply auctions instead of "keeping the lights on? Some comments about the new way to ensure Supply Adequacy and to improve the performance of electricity markets in Brazil, Chile and Peru', <http://www.dundee.ac.uk/cepmlp/car/html/CAR10_ARTICLE27.PDF> accessed 08.04.2013.
[125] JOSKOW P.L., 'Markets for Power in the United States: An Interim Assessment', 2006, <http://economics.mit.edu/files/1184>, accessed 25.02.2018, p. 10.
[126] CAMERON P.D., *Competition in Energy Markets: Law and Regulation in the European Union*, Oxford University Press, New York, 2007.
[127] *ibid*.
[128] *ibid*.
[129] IEA, 'Energy Market Reform: Power Generation Investment in Electricity Markets', OECD/IEA, Paris, 2003, <https://www.hks.harvard.edu/hepg/Papers/Fraser.gen.invest.elec.mkts.1203.pdf> accessed 25.02.2018, p.16.

al. notes that "(t)he most convincing argument against energy-only markets lies in the difficulties for regulatory authorities to distinguish between the exercise of market power and legitimate scarcity rent."[130] Therefore, price-cap regulation in electricity markets, which is put in place to deal with market power abuse, are quite common around the world. In this regard, L΄eautier indicates that the operational and regulatory exercises of System Operators (SOs) such as imposing *de jure* or *de facto* price caps in order to prevent market power abuse are frequently thought to be the main source of the missing money problem which is considered as the chief driver of underinvestment in generating capacity.[131] In this direction, Green stated that even in well-developed US electricity markets, electricity prices have not increased satisfactorily to cover investors' fixed costs due to the fact that SOs suppress prices by buying some of their necessities through out of market mechanisms.[132]

It can be asked that why price cap is not put at the level of (Value of Lost Load) VOLL so as to both induce new generation investments and avoid market power abuse. VOLL is defined as:

> "a measure of the economic value given to an amount of electricity that is prevented from being delivered to consumers (i.e. is 'unserved') as a result of a planned or unplanned outage of one or more components of the electricity supply chain. That is, the amount which consumers, on average, would be prepared to pay to avoid an outage."[133]

By setting a price cap at the level of VOLL, the missing money problem may be overcome without needing any CRM as CRMs are mainly established to cover investment costs, which would normally be covered by price mechanisms in the market. Indeed, Joskow argues that

[130] ROQUES F.A., NEWBERY D.M. and NUTTALL W.J., 'Investment Incentives and Electricity Market Design: the British Experience', (2005), 4 *Review of Network Economics* pp.93-128, p.97.
[131] LEAUTIER T.O., 'The visible hand: ensuring optimal investment in electric power generation', 2015, <https://www.tse-fr.eu/sites/default/files/TSE/documents/doc/by/leautier/15_03_13_capacity_markets.pdf> accessed 11.10.2017, p.2.
[132] GREEN R., 'Are the British electricity trading and transmission arrangements future-proof?', (2010), 18 *Utilities Policy* 186-194, p.192.
[133] HIKO T.M., 'Investigation into the value of lost load in New Zealand – Summary of findings', 2012, <https://www.ea.govt.nz/dmsdocument/12365> accessed 11.10.2017, p.1.

as long as electricity prices are allowed to jump up to the level of VOLL in scarcity conditions, markets can produce adequate generation capacity.[134] However, this proposition does not always turn into practice in real life due to two basic reasons: First, calculating the right level of VOLL is not an easy task, if not impossible.[135] Cramton and Stoft notes that:

> "Theoretically, it would be possible to set shortage prices sufficiently high to provide sufficient investment incentives, as is the case with value of lost load (VOLL) pricing […], but this approach entails estimating VOLL—a nearly impossible task. Moreover, it exposes load to greater price risk in real time, and the high shortage prices encourage generators to withhold supply to create shortages, which undermines reliability. Thus, in practice, shortage prices have generally been set at levels on the order of $1000, and even lower, such as the $250 cap in the California market during a time of great scarcity (2000-2001). In contrast, the value of lost load estimates is often in the $10,000 to $20,000 range."[136]

Joskow, in contrast, opposes the view that price cap regulation is the only source of the missing money problem. According to Joskow, although price caps are set far below

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[134] JOSKOW P.L., 'Capacity Payments in Imperfect Electricity Markets: Need and Design', *Supra* note 83, p. 9.

[135] The reason why calculating the right level of VOLL is extremely hard because it depends on many variables: (1) Customer types: These types can be divided into a great number of groups from different perspectives such as income level, size and region for householders and industrial sector, regions and sizes for companies; (2) The perceived reliability level: This factor is about the level to which customers prepare for blackout and how they price the lost load. Of course, reliability perception of different customer groups is naturally different. Estimating VOLL for every single reliability perception of each customer is thus an incredibly complex process; (3) The time of interruptions: While there can be only a nuisance between electricity interruption in leisure time and working hours, for businesses the opposite is true since the cost in industry predominantly occur during production hours; (4) The duration of an interruption: It is differently effect different sectors. While some sectors can be detrimentally affected even from a short lengthy of blackout, others can be more robust against blackouts. Therefore, VOLL can be changed for different customers in terms of the duration of interruption. *See*, European Commission, Identification of Appropriate Generation and System Adequacy Standards for the Internal Electricity Market' *Supra* note 40, p. 48.

[136] CRAMTON P. and STOFT S., 'A Capacity Market That Makes Sense', 2005 <https://drum.lib.umd.edu/bitstream/handle/1903/7083/cramton-stoft-a-capacity-market-that-makes-sense.pdf?sequence=1> accessed 17.05.2017, p.2.

estimations of the VOLL, it is apparent that even throughout the worst scarcity conditions electricity prices are below the price caps.[137] He further indicates that within the context of US electricity markets, other regulatory decisions taken by SOs to maintain reliability of the network destroy prices more than the price cap placed on electricity and ancillary markets.[138] As mentioned, Joskow carried out this evaluation for the US electricity markets, but an incident in the UK electricity market also justifies his opinion. The UK had to use *"last resort"* measures to keep the lights on in November 2015 for the first time in history. The reason behind this was that multiple coal power plants broke down due to unexpected maintenance requirements and 6,500 onshore and offshore wind turbines produced less than 1% of required electricity because of low wind speeds.[139] Also, Britain's 8,000 MW of solar power capacity did not generate any electricity during that time because it was night time.[140] Under this heavy scarcity conditions, the wholesale electricity prices increased up to £2,500 per megawatt-hour, 50 times higher than average power prices.[141] At first glance, it can be assumed that this tremendous price spike is sign of a functioning electricity market. Nevertheless, it should be noted that according to an estimation made by London Economics for the UK government and Ofgem, VOLL for the UK customers at peak times is around £17,000 per megawatt-hour.[142] As can be seen, then, even under the worst scarcity conditions, wholesale electricity prices cannot rise sufficiently enough to reach VOLL. This can actually be regarded as a result of out-of-market mechanisms or regulatory decisions mentioned by Joskow cited above. In point of fact, Joskow mentioned the difference between an implicit and explicit price cap. This difference is discussed in the next chapter as it seems more relevant for the EU electricity markets.

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[137] JOSKOW P.L., 'Capacity Payments in Imperfect Electricity Markets: Need and Design', *Supra* note 83, pp. 21-22.
[138] *ibid*, p.22.
[139] GOSDEN E., 'National Grid uses 'last resort' measures to keep UK lights on', 04.11.2015, <http://www.telegraph.co.uk/finance/newsbysector/energy/11975069/Power-plant-breakdowns-force-National-Grid-to-issue-alert.html> accessed 04.11.2015.
[140] *ibid*.
[141] *ibid*.
[142] European Commission, 'State aid SA.35980 (2014/N-2) – United Kingdom Electricity market reform – Capacity market', Brussels, 23.7.2014 C (2014) 5083 final, <http://ec.europa.eu/competition/state_aid/cases/253240/253240_1579271_165_2.pdf> accessed 04.03.2018, p.21.

Second, Roques et al put forward that investors may not rely on just periodic price spikes to decide their future generation investments.[143] This is understandable because trusting periodic price spikes to recover investment costs can be highly uncertain for risk averse generation investors. Risk averse is a term that defines investors unwilling to take risks or who seek to evade risks as much as possible.[144] Abani et al[145] and Petitet[146] argue that energy-only markets with a price cap can be regarded as unreliable for risk averse investors compared to electricity markets with CRMs. In line with this argument, Neuhoff and De Vries shows that unless there is sufficient volume of long-term contracts with consumers, risk averse investors do not make adequate generation investments by relying on price spikes in energy-only markets.[147] So, even if it is assumed that a price cap can be practically designed at the level of VOLL, risk averse investors may not provide sufficient generation capacity.

3.2.2.1 The Rise of Intermittency: Exacerbating factor of the missing-money problem

As can be seen in Figures 6, 7 and 8 below, the proportion of wind and solar power in generation mixes have dramatically increased in most jurisdictions around the world over the last decade.

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[143] ROQUES F.A., NEWBERY D.M. and NUTTALL W.J., 'Investment Incentives and Electricity Market Design: the British Experience', *Supra* note 130, pp.97-98.
[144] Cambridge Dictionary, 'Risk-Averse', <http://dictionary.cambridge.org/dictionary/english/risk-averse> accessed 04.11.2015.
[145] ABANI A.O. et al, 'Risk aversion and generation adequacy in liberalized electricity markets: benefits of capacity markets', 13th International Conference on the European Energy Market (EEM), 06-09 June Porto/Portugal, 2016.
[146] PETITET M., 'Effects of risk aversion on investment decisions in electricity generation: What consequences for market design?', 13th International Conference on the European Energy Market (EEM), 06-09 June Porto/Portugal, 2016. p.5.
[147] NEUHOFF K. and DE VRIES L., 'Insufficient incentives for investment in electricity generations', (2004), 12 *Utilities Policy*, pp. 253-267.

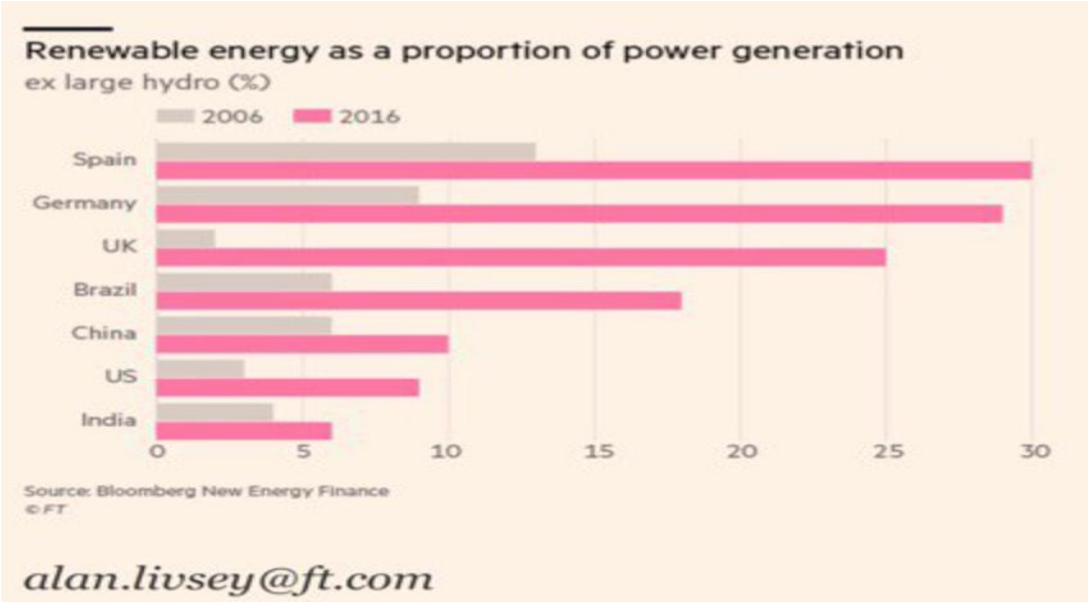

Figure 6 Renewable energy proportion in electricity generation between 2006 and 2016[148]

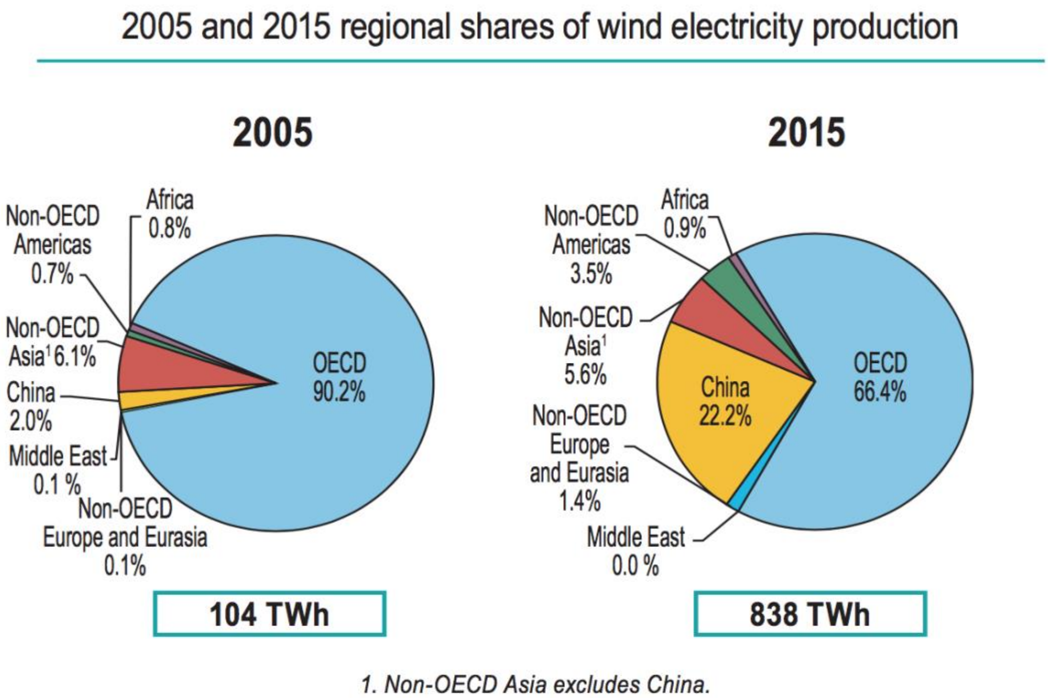

Figure 7 2005 and 2015 Regional Shares of Wind Electricity Production[149]

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[148] GLACHANT J. M. (@JMGlachant), "The boom in renewables generation investments is visible last decade in many countries", 15.09.2017, 5:45 AM, Tweet.
[149] IEA, 'Key World Energy Statistics', (2017), <https://www.iea.org/publications/freepublications/publication/KeyWorld2017.pdf> accessed 10.01.2018, p.22.

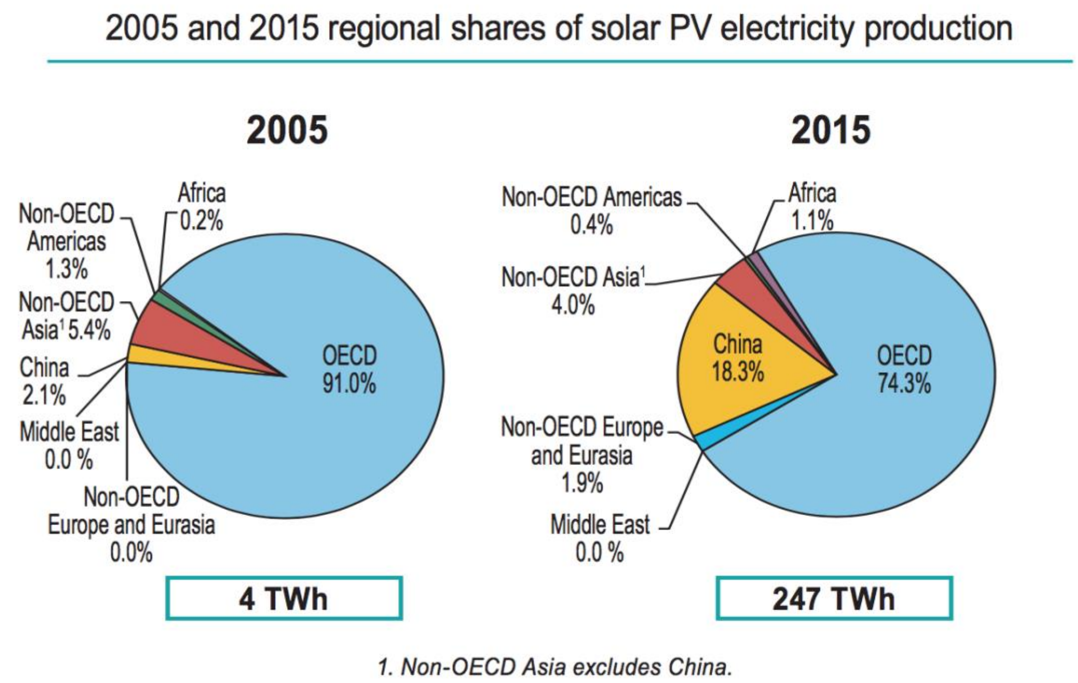

Figure 8 2005 and 2015 Regional Shares of Solar PV Electricity Production[150]

Furthermore, within the EU context, intermittent RESs are expected to correspond to around 94% of total electricity demand in Denmark, 63% in Ireland, and 53% in the UK until 2030.[151] The highly ambitious 2030 targets (at least 40% reduction in domestic greenhouse gas emissions, at least 27% improvement in energy efficiency and at least 27% renewables share of total electricity consumption at the EU level) set out by the European Council in October 2014 will further increase the share of intermittent RESs in Member States' generation mixes, estimated to reach up to 50% of electricity generation.[152] Understandably, these statistics and expectations reveal that generation adequacy concerns will be even worse in both Europe and throughout the world due to the rise of intermittency.

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[150] *ibid*, p.24.
[151] HAAS R. et al, 'The Growing Impact of Renewable Energy in European Electricity Markets', *Supra* note 49, p.131.
[152] European Commission, 'Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Launching the public consultation process on a new energy market design', Brussels, 15.7.2015, COM(2015) 340 final, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015DC0340&from=EN> accessed 04.03.2018, p.3.

The reason why intermittent RESs exacerbate generation adequacy concerns is that neither wind nor solar power can supply *firm capacity*[153] and they can therefore substitute only a small part of conventional generators such as coal and gas plants.[154] Moreover, intermittent RESs increase price volatility, reduce general price levels and deteriorate the capacity utilisations of coal and gas power plants.[155] In line with this argument, Bauknecht et al explained the detrimental effect of intermittent RESs for generation adequacy from two perspectives: (1) The dominance of intermittent RESs in electricity markets increases the unpredictability of supply. The higher the share of intermittent RESs, the more vital it is to deliver for adequate volumes of reliable backup or storage capacity to overcome the risk of a gap in RES supply; and (2) With increasing share of RESs, the utilisation rates of conventional power plants decrease, leading to even higher peak prices to compensate for investment costs.[156]

In a recent report, the IEA puts forward that intermittent RESs including sunlight and wind have five basic differences from conventional power plants: (1) Their generation levels fluctuate depends on the real time availability of sun and wind; (2) These fluctuations can only be forecasted with remarkable success for a few hours ahead, although some fairly accurate predictions can be made a few days in advance; (3) Their connection to the grid needs a different type of technology called converter technology which is relevant especially in terms of electricity system stability, for instance, after an unforeseen shutdown of a generator; (4) They exhibit a much larger footprint (in terms of size of the power plant) in comparison to conventional power plants, and are located at a considerable distance from each other again in comparison to conventional power plant; and (5) Unlike fossil-based energy sources, these resources cannot be transported, and the siting (location) of such plant where they can attain

[153] Firm capacity can be defined as the amount of energy that must be guaranteed to be available at a given time. *See,* ENERGYVORTEX.COM, 'Energy Dictionary: Firm Capacity', <https://www.energyvortex.com/energydictionary/firm_capacity__firm_energy__nonfirm_energy__firm_power.html> accessed 23.11.2017.
[154] CRAMTON P., OCKENFELS A. and STOFT S., 'Capacity Market Fundamentals', (2013), *Economics of Energy & Environmental Policy*, Vol. 2, No. 2. <ftp://www.cramton.umd.edu/papers2010-2014/cramton-ockenfels-stoft-capacity-market-fundamentals.pdf> accessed 11.10.2017, p.40.
[155] *ibid*.
[156] BAUKNECHT D. et al, 'From Niche to Mainstream: The Evolution of Renewable Energy in the German Electricity Market' in SIOSHANSI F. (ed), *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, 2013, p.191, pp.169-198.

the best level of availability are commonly far from consumers.[157] In terms of the context of this study, the first two differences regarding intermittent RESs are more relevant since these differences indicate the lower level of reliability of these resources when compared to conventional power plants. The reason behind this is that the firm capacity of intermittent RESs is considerably low, which makes these sources less reliable. As noted by Haas et al, large intermittent RESs capacity investments do not automatically convert into generation owing to the lower capacity factors[158] of wind and solar powers; that is, a normal wind farm may work around 1,800-2,300 hours in a year while solar power generator may work about 8,00-1,200 hours in a year, depending on the location.[159] Therefore, according to an analysis, each MW of wind capacity commonly needs 1 MW of back-up capacity to guarantee 90% availability.[160] Of course, since electricity systems are not mostly island systems, the argument of "1 MW wind capacity needs 1 MW back-up" can be changed through increasing interconnections, developing storage facilities including pump storage, district heating systems, electric vehicles and demand side management mechanisms such as interruptible supply contracts.[161] However, it is still a strong fact that intermittent RESs need a high level of back-up capacity. In another study, on this issue, it is stated that "the level of firmness […] of intermittent energy sources is quite limited (5-10% maximum) which means that they can

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157 IEA, 'Next Generation Wind and Solar Power From Cost to Value' OECD/IEA, 2016 <http://www.iea.org/publications/freepublications/publication/Next_Generation_Windand_Solar_PowerFrom_Cost_to_ValueFull_Report.pdf> accessed 04.03.2018, p.20.

158 Capacity factor can be defined as the percentage of average working hours of a power plant in a year. For instance, while capacity factor of solar power plant lies between 10-30%, wind plants' capacity factor changes between 20-50%. *See*, IEA, 'Getting Wind and Sun onto the Grid', A Manual for Policy Makers, Insights Series 2017, OECD/IEA, 2017, <http://www.iea.org/publications/insights/insightpublications/Getting_Wind_and_Sun.pdf?utm_content=buffer2f188&utm_medium=social&utm_source=twitter-ieabirol&utm_campaign=buffer> accessed 04.03.2018, p. 10.

159 HAAS R. et al, 'The Growing Impact of Renewable Energy in European Electricity Markets', *Supra* note 49, p.130.

160 EURELECTRIC, 'Integrating Intermittent Renewables Sources into the EU Electricity System By 2020: Challenges and Solutions', <https://www.researchgate.net/profile/Dr_Andreas_Poullikkas/publication/258402979_Integrating_intermittent_renewables_sources_into_the_EU_electricity_system_by_2020_challenges_and_solutions/links/00b7d52824c7dd07a0000000/Integrating-intermittent-renewables-sources-into-the-EU-electricity-system-by-2020-challenges-and-solutions.pdf> accessed 04.03.2018.

161 *İbid*.

be considered as energy sources but not as capacity suppliers."[162] Furthermore, the same study gives a stunning example as follows:

> "[A] system with a peak demand of 40,000 MW, and without any intermittent RES capacity, would require 44,000 of installed conventional capacity with high level of firmness to guarantee a 10% reserve margin over peak demand. If the same system included 20,000 MW of wind with a capacity credit of 2,000 MW (10%), then there would still be a need for 42,000 MW of conventional firm capacity to guarantee the 10% reserve margin – i.e. hardly less conventional capacity than in the previous system without wind generation."[163]

Of course, these calculations about back-up capacity requirement for intermittent RESs can vary from situation to situation. For instance, the IEA notes that capacity credits of intermittent RESs are changed based on different factors such as season, location, and generation mix.[164] However, at the end of the day, it is clear that these sources are considerably less reliable than conventional power plant. In light of these facts, it is not hard to say that greater amounts of renewable energy investments may contribute to climate change objectives and save the money spent for fuels. On the contrary, electricity markets with increasing share of RESs need large levels of back-up (flexible) capacity to ensure generation adequacy.

3.2.3 Other Reasons

3.2.3.1 Boom-and-bust or Investment Cycle

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[162] EURELECTRIC, 'RES Integration and Market Design: Are Capacity Remuneration Mechanisms Needed to Ensure Generation Adequacy?', May 2011, <https://www3.eurelectric.org/media/26300/res_integration_lr-2011-030-0464-01-e.pdf> accessed 04.03.2018, p.12.

[163] *ibid.*

[164] IEA, 'Getting Wind and Sun onto the Grid', *Supra* note 158, p.10.

Capital investment industries in general are disposed to investment cycles.[165] Investment cycles have been experienced in a number of markets comprising automobile manufacturing, real-estate construction and commodity production.[166] A relevant analogy can be made between real estate construction and new power plant construction. In both industries, there exists a challenge regarding the timely investment to meet increasing demand. Figure 9 below illustrates a classical boom-and-bust cycle for the real-estate construction industry in Chicago.

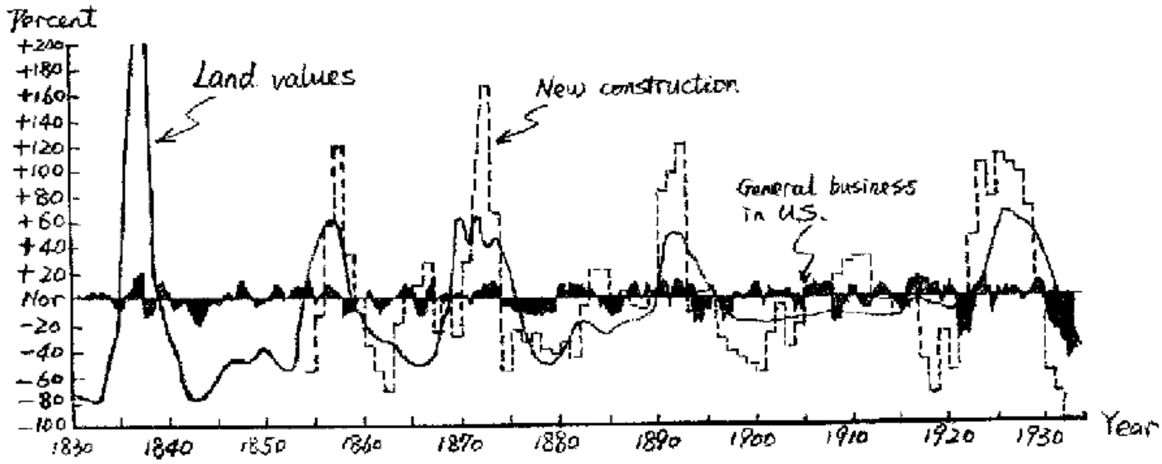

Figure 9 Land values and construction cycles in Chicago[167]

When it comes to electricity industry, Ford believed that the boom-and-bust cycle can be more volatile in electricity markets than for other commodities because it is non-storable and thus generation and consumption must be simultaneous.[168] This simultaneity, Ford stated, forced electricity market structures to be changed in order to provide an extra capacity requirement.[169] The IEA also called the investment cycle the "biggest challenge" of liberalisation in electricity markets.[170] Arango and Larsen analysed English and Chilean

[165] GREEN R., 'Investment and generation capacity' in LÉVÊQUE F. (Eds.), *Competitive Electricity Markets and Sustainability,* published by Edward Elgar Publishing Limited, Cheltenham, UK, 2006, p. 35.
[166] FORD A., 'Cycles in competitive electricity markets: a simulation study of the western United States', (1999), 27 *Energy Policy*, 637-658.
[167] HOYT H., *One Hundred Years of Land Values in Chicago,* University of Chicago Press, (1933), p.387 cited in FORD A., 'Boom & Bust in Power Plant Construction: Lessons from the California Electricity Crisis', To Appear in the Special Issue of the Journal of Industry, Competition and Trade on the California Energy Crisis, <http://public.wsu.edu/~forda/JournalofIndustry.pdf> accessed 08.04.2013.
[168] *ibid*.
[169] *ibid*.
[170] IEA, 'Energy Market Reform: Power Generation Investment in Electricity Markets', *Supra* note 129, p.89.

Electricity Markets to test the "Investment Cycle Hypothesis".[171] They reached the conclusion that investment dynamics in electricity generation markets led to cyclical behaviours which threatened security of supply.[172]

3.2.3.2 Forward Markets in Energy-only Markets: Why are not they adequately employed for attracting generation investments?

One may rightly ask why forward markets are not employed in liberalised electricity markets so as to overcome generation adequacy challenges. This is a legitimate question. In the forward market, market players can use long-term contracts[173] for electricity trade.[174] Long-term contracts can be defined as "any contracts for electricity supply of longer duration than spot energy supply."[175] Such contracts are predominantly used for hedging risks including price risks caused by the high price volatility of spot markets and volume risks for generators such as RESs, large electricity customers and distributors.[176] As a very well-known fact, long-term contracts are useful tools for the financing of large-scale energy investments as occurs in the electricity industry.[177] Furthermore, long-term contracts can be highly useful for consumers because they prevent generators from capacity withholding during scarcity times.[178] There are a range of different types of long-term contracts such as Power Purchase

[171] ARANGO S. and LARSEN E., 'Cycles in deregulated electricity markets: Empirical Evidence from two decades', (2011), 39 *Energy Policy,* pp.2457-2466.
[172] *ibid*.
[173] Long-term contracts can be designed for different segments and areas of electricity markets such as accessing transmisson or distribution lines, but here long-term contracts are used in the meaning of electricity supply.
[174] TENNBAKK B. et al, 'Capacity Mechanisms in Individual Markets within the IEM', THEMA Consulting Group, 28.05.2013, <https://ec.europa.eu/energy/sites/ener/files/documents/20130207_generation_adequacy_study.pdf> accessed 27.05.2015, p.17.
[175] MEADE R. and O'CONNOR S., 'Comparison of Long-Term Contracts and Vertical Integration in Decentralised Electricity Markets', LARSEN-EUI Workshop on "Efficiency, Competition and Long Term Contracts in Electricity Markets", European University Institute, Florence, 15-16 January 2009 <http://www.gis-larsen.org/pdf/Meade.pdf> accessed 04.03.2018.
[176] MANTYSAARI P., *EU Electricity Trade Law: The Legal Tools of Electricity Producers in the Internal Electricity Market*, Springer, London, 2015, p. 465.
[177] *ibid*.
[178] DE VRIES L.J. and HAKVOORT R.A., 'The question of generation adequacy in liberalised electricity markets', *Supra* note 69.

Agreements (PPAs),[179] Contract for Differences as financial instruments and Bulk Contracts with fixed or flexible volumes.[180] As can be guessed, these contracts are crucial to attract new generation investments. However, although their benefits are not secret, long-term contracts are not used at the desired intensity in electricity markets. In other words, forward markets have not been adequately developed in order to attract new generation investment. For instance, in Germany, as illustrated on Figure 10 below, while forward contracts signed in 2015 for the forward period of 2016 amounted to 65% of total electricity generation in 2014, contracts concluded for the forward period of 2019 only amounted to 2% of total electricity generation in 2014.[181] On this issue, Genoese et al note that:[182]

> "One reason for this decrease in liquidity is that risk premiums grow exponentially with the delivery date. There are no suitable long-term hedging instruments - neither for relevant production cost factors (price of coal, gas, carbon), nor for the risk of a regulatory intervention, or for the counterparty default

[179] PPAs are long-term contracts that are concluded between a government agency and a private entity so as to establish a power plant. In PPAs, on one hand private entities commit to provide agreed amount and quality of electricity and/or capacity within the agreed timescale, on the other hand the government agency commit to buy the agreed amount of electricity and/or capacity throughout the life of that specific power plant. Here, it should be distinguished between PPAs in vertically integrated electricity industry or electricity market model based on single-buyer model and PPAs in liberalised electricity markets. The definition of PPAs made above is suitable for vertically integrated electricity industries or electricity markets based on single-buyer model. According to Hunt, the single buyer model is "[a] market structure based on long-term contracts, like the IPP markets under regulation, transfers market risk, technology risk, and most of the credit risk back to customers because the IPP contracts shelter the IPPs from market prices and improved technologies […]." Furthermore, Hunt indicates that the long-term contracts are required in the single-buyer model due to lack of enough buyers for competition. PPAs employed in liberalised electricity markets can be regarded as typical contracts for purchase of power from a private generator where power plant has already existed or where power plant is under construction without taking any guarantee from any government agency. *See* World Bank, 'Power Purchase Agreements (PPAs) and Energy Purchase Agreements (EPAs)', <https://ppp.worldbank.org/public-private-partnership/sector/energy/energy-power-agreements/power-purchase-agreements#deregulated> accessed 13.09.2017 and HUNT S., *Making Competition Work in Electricity Markets*, *Supra* note 101, p. 43.

[180] MANTYSAARI P., *EU Electricity Trade Law: The Legal Tools of Electricity Producers in the Internal Electricity Market, Supra* note 176, p. 474.

[181] GENOESE F. et al, 'The EU power sector needs long-term price signals' CEPS Special Report, No.135, April 2016, <https://www.ceps.eu/system/files/SR135%20LongTermPriceSignals_0.pdf> accessed 04.03.2018, p.9.

[182] *Ibid*.

risk. As a result, the current demand of end-consumers for long-term contracts is close to zero."

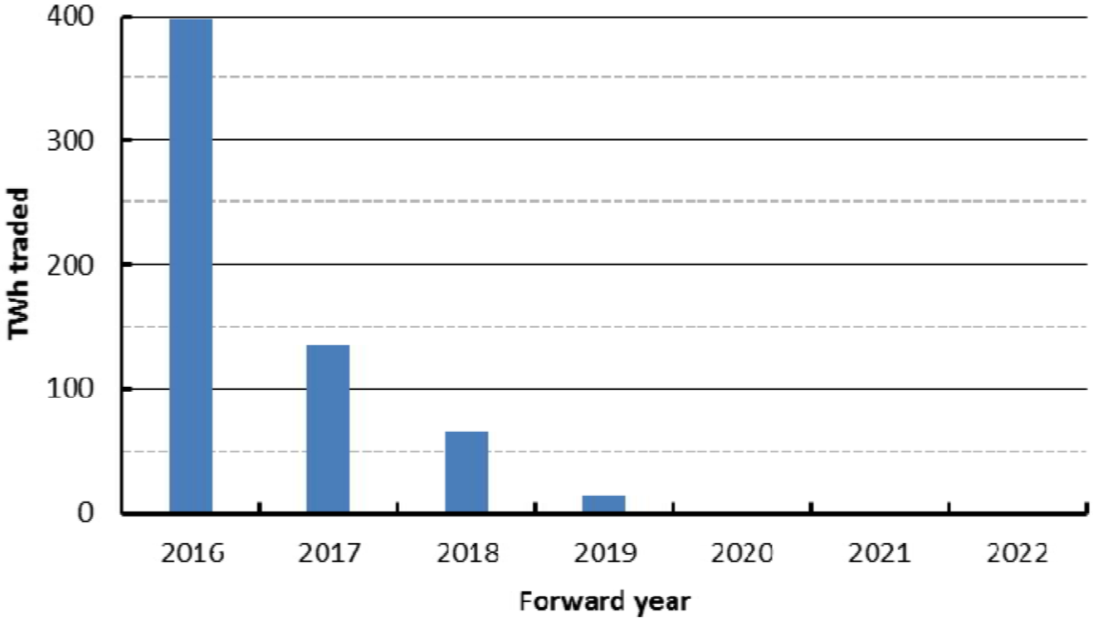

Figure 10 Volume of forward contracts in the trading year 2015 in the German power market

Similar to Germany, as the forward period increases the number of secured contracts appear to fall, or even decline close to zero in the UK electricity market (*See* Figure 11 below).

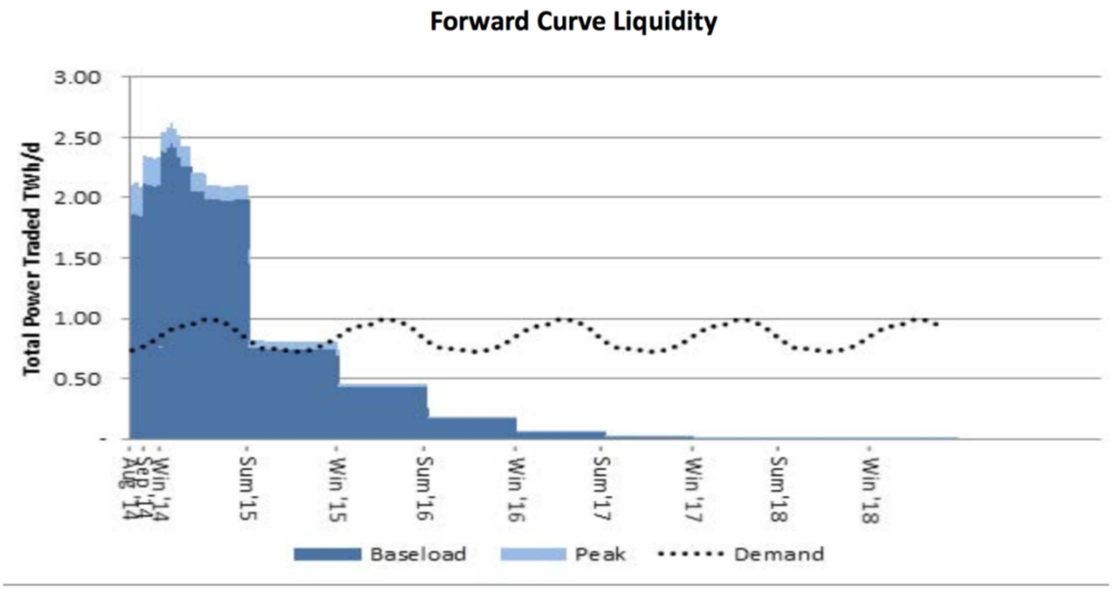

Figure 11 Volume of forward contracts in the UK electricity market[183]

Weiss and Sarro also confirmed the fact that market liquidity in forward markets is inversely proportional to the due dates of long-term contracts. According to recent research conducted by Weiss and Sarro prepared for Ridgeline Energy LLC, "forward markets for energy, capacity and RECs [Renewable Energy Certificates], where they exist at all, are liquid often only for relatively short periods of time."[184] Moreover, Weiss and Sarro claimed that this situation has been getting worse following the Global Financial Crisis in 2008.[185]

There are various reasons why electricity markets cannot produce enough long-term contracts:

1. *Free-riding problem:* De Vries and Hakvoort clearly explained the free riding problem among final consumers in terms of long-term contracts in liberalised electricity

[183] ENERGY UK, 'Wholesale Market Report' March 2016, <https://www.energy-uk.org.uk/publication.html?task=file.download&id=5748> accessed 25.02.2018, p.6
[184] WEISS J. and SARRO M., 'The importance of long term contracting for facilitating renewable energy project development', The Brattle Group, 07.05.2013, <http://www.brattle.com/system/publications/pdfs/000/004/927/original/The_Importance_of_Long-Term_Contracting_for_Facilitating_Renewable_Energy_Project_Development_Weiss_Sarro_May_7_2013.pdf?1380317003>, accessed 25.02.2018, p.2.
[185] *Ibid*.

markets. According to them, generators sell their electricity to retailers instead of final consumers. This creates room for opportunistic behaviour for some consumers. That is, some consumers choose cheap retailers with insufficient long-term contracts under normal conditions while other consumers pay more to other expensive retailers with sufficient long-term contracts in order to ensure secure electricity supply.[186] However, all consumers regardless of whether they pay for adequacy or not will benefit from security of supply.[187] This problem understandably discourages consumers and/or retailers from entering into long-term contracts.

2. *Not long enough long-term contracts[188]:* As discussed above, there are long-term contracts, by definition, in electricity markets such as in Germany and the UK. However, these contracts are not long enough to overcome the challenge of the investment cycle problem mentioned above.
3. *Demand-side challenges:* Even assuming sufficient long-term contracts are made, it still may not be enough for the following two reasons:
   i) Electricity markets are suffering from demand inelasticity caused by the unique nature of electricity itself.[189] Due to this fact, demand-side are not playing a critical role in electricity markets since regulated tariffs (price-cap regulation) protect consumers from unacceptable price spikes.[190] Therefore, even though consumers can enter into long-term contracts, they may not determine their reliability standards on their own which creates difficulties for attracting reliability-oriented generation investments.[191]

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186 DE VRIES L., 'Generation Adequacy: Are electricity markets instable in the long run?', 24.06.2011 <https://ocw.tudelft.nl/wp-content/uploads/4_Generation_adequacy_01.pdf> accessed 25.02.2018, slides 28
30 and DE VRIES L.J. and HAKVOORT R.A., 'The question of generation adequacy in liberalised electricity markets', *Supra* note 69.
187 *Ibid*.
188 This subtitle is taken from the following work: DE VRIES L.J. and HAKVOORT R.A., 'The question of generation adequacy in liberalised electricity markets', *Supra* note 69.
189 STOFT S., *Power System Economics: Designing markets for Electricity*, *Supra* note 22, p.15.
190 PEREZ-ARIAGA I.J., 'Engineering, Economics and Regulation of the Electric Power Sector', Lecture Notes, <https://ocw.mit.edu/courses/engineering-systems-division/esd-934-engineering-economics-and-regulation-of-the-electric-power-sector-spring-2010/lecture-notes/MITESD_934S10_lec_19.pdf> accessed 13.04.2014.
191 *Ibid*.

ii) Even if the conditions do exist in which consumers can react to electricity prices, they may tend to ignore reliability issues in their decision-making owing to their expectation from government to protect them from any kind of electricity crisis.[192]

4. Design Criteria and Types of CRMs

CRMs are regulatory tools to provide incentive-based guarantees for investors to help their long-term investment decisions. These tools manage and coordinate new investment decisions to attract new capacity resources and guarantee that adequate generation capacity will be available when they are needed at any time.[193] According to Ausubel and Cramton, these markets can solve three basic problems: market power, risk, and investment.[194] In this sense, it can be said that the basic purpose of all types of CRMs is to attract adequate investment for generation capacity in the long-run.[195]

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[192] *Ibid*.

[193] AUSUBEL L. M. and CRAMTON P., 'Using Forward Markets to Improve Electricity Market Design', *Supra* note 86.

[194] *ibid.*

[195] It is clear that one of the most understandable legitimate concerns about CRMs is their potential to increase costs for final consumers. To reduce these concerns and provide as cheap electricity as possible for citizens, governments should take all necessary precautions when implementing CRMs in their jurisdictions. In this regard, it is critical for governments to implement a well-designed auction in order to procure capacity as cheap as possible. This is crucial for affordability which is one of the main pillars of energy policy objectives for all countries. Therefore, selecting the right type and design of auction is strategically important for CRMs. In simplest term, the term auction can be defined as “a selection process designed to procure (or allocate) goods and services competitively”. It is a well-known fact that free market systems have employed auctions for commercial occupations for a very long time as well as other systems including fixed pricing and negotiation. For instance, Heredotos recorded that the Babylonians used two forms of auctions in order to offer their young ladies in marriage as early as 500 B.C. However, as noted by Unkovic, in today’s context the auctioning system was firstly used by the Romans. In addition to the Babylonians and the Romans, other cultures including Chinese, English and American employed auctioning systems in different time periods in history. Auctions are steadily more employed in order to ensure the efficient allocation of scarce resources in many sectors from artwork to airwaves. Naturally, electricity markets are also using auctioning systems to get best prices for consumers through competitive biddings. There are a range of types of auctioning systems such as Sealed-bid auction, Descending clock auction, Hybrid auction, Combinatorial and Two-sided auctions. On the other hand, it is known that, fundamentally, there are two forms of auctioning systems: Traditional and Reverse auctions. In traditional auctions, a seller simply tries to sell a product or a certain amount of products to a buyer who offers the highest bid among a group of buyers. On the other hand, in reverse auctions, a buyer (generally a public body) tries to buy a certain amount of products from a group of sellers who offer the lowest bid. The process for a reverse auction starts with defining the specific requirement of buyer. Following defining the requirement of buyer, qualified suppliers are invited to participate in

Several types of CRMs have been developed to date. Within the scope of this research, the term CRM is employed as an umbrella term which includes capacity payments, strategic reserve, capacity obligation, capacity auctions and reliability options. In broad terms, they can be grouped depending on whether they are price-based or quantity-based. Quantity-based mechanisms can be further classified as market-wide or targeted mechanisms. Before analysing each CRM, Table 3 below sets out the terms of these criteria. It also provides a brief summary of each type of CRM.

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the auction and compete with each other through bidding. In general terms, this bidding process can be organized as either sealed-bid, which is a method that competitors cannot see others' bids, or open-bid, whereby all competitors can see what others bid. It can be argued that there are two objectives of reverse auctions: Minimizing the costs of procurement for buyers and efficiency. Due to these crucial reasons, many governments are employing reverse auctions in different segments of their electricity markets. Unsurprisingly, reverse auctioning systems are employed for procuring capacity product in many CRMs around the world such as PJM, MISO, NYISO, ISO New England and the UK. It should be noted that although all these electricity markets are using reverse auctions, designs of their auctions are naturally different. While PJM, MISO and NYISO are employing sealed-bid reverse auctions, ISO New England and the UK are using descending clock reverse auctions. Of course, different types of reverse auctions have different advantages and disadvantages. However, since this issue exceeds the scope this thesis, it will not be discussed further. Nevertheless, it should be kept in mind that the right choice of auction type has strategic importance in the design of CRMs. *See* MAURER L. T. A. and BARROSO L. A., 'Electricity Auctions: An Overview of Efficient Practices', The World Bank Washington, D.C., 2011, <http://documents.worldbank.org/curated/en/114141468265789259/pdf/638750PUB0Exto00Box0361531B0PUBLIC0.pdf> accessed 04.03.2018, p. XII; DuBOFF, L.D., 'Auction Problems: Going, Going, Gone', (1977), 26 *Cleveland State Law Review*, pp. 499-513, p.499; UNKOVIC, N., 'The Three Types of Auction Sales, (1929), 34 Dickinson Law Review, pp.233-243, p. 233; LEATUIER, T.O., 'Electricity Auctions', (2001), 10 *Journal of Economics & Management Strategy*, pp.331-358, p.332; CHENG, C., 'Solving a sealed-bid reverse auction problem by multiple criterion decision-making methods', (2008), 56 *Computers and Mathematics with Applications*, pp. 3261-3274, p.3261; TRIFUNOVIĆ, D. and RISTIĆ, B., 'Multi-unit Auctions in the Procurement of Electricity', (2013) LVIII *Economic Annals*, pp. 47-77, p.50; CHANG, J. et al, 'Two Capacity Auction Formats: Single Bid Sealed Round vs. Descending Clock Multi-Round', 31.07.2017, < https://www.aeso.ca/assets/Uploads/Brattle-Capacity-Auction-Formats-Presentation.pdf> accessed 07.10.2018.

Table 3[196]: Taxonomy of CRMs[197]

Price/Volume Based	Types of CRMs	Definition
Price based	Capacity payments	This is a price-based measure in which capacity providers get a fixed amount of payments in addition to revenues earned from energy sales in the market. The amount is determined by an independent authority in the expectation that it enhances the incentives to attract new investment and/or maintain existing capacity. Capacity payments can be designed as market-wide or targeted.
Volume based	Strategic reserves	This is a targeted measure in which contracted capacity is set aside and only bid into market when the market cannot cover the demand.
	Reliability options	This is a market-wide measure. Roughly speaking, reliability options are similar to call options contracted through centralised auction. Capacity providers that have reliability options must pay the difference between spot price and strike price (determined by an independent authority) whenever this difference is positive.
	Capacity obligations	This is a market-wide and decentralised measure where obligations are imposed on suppliers to contract for capacity which should be higher than their expected or contracted consumption or supply obligations to a certain level. Contracted

[196] This table with two extra columns was prepared by the author to contribute a chapter for an edited book named *"Energy Transitions: Regulatory and Policy Trends"* edited by Sirja-Leena Penttinen and Ioanna Mersinia. This book was published in February, 2017. The reason for the removal of the two columns on the table is that they are directly related to the European CRMs which are addressed in following chapters. *See,* ŞAHİN T., 'Integration of European Capacity Remuneration Mechanisms: In Search of a Harmonized Regulatory Framework', in PENTTINEN S.L. and MERSINIA I. (eds.), *Energy Transitions: Regulatory and Policy Trends*, Volume 5, Intersentia, UK, 2017, pp. 15-16, pp. 11-33.

[197] Own illustration based on: Agency for the Cooperation of Energy Regulators (ACER), 'Capacity Remuneration Mechanisms and the Internal Market for Electricity', 30.07.2013, <http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/CRMs%20and%20the%20IEM%20Report%20130730.pdf> accessed 27.05.2015, pp. 5-8; TENNBAKK B. et al, 'Capacity Mechanisms in Individual Markets within the IEM', *Supra* note 174, pp. 30-35; BARTH T. et al, 'Renewable Energy and Security of Supply: Finding Market Solutions', Eurelectric Report, October 2014, <http://elyntegration.eu/wp-content/uploads/2014_RES_Supply_Market_eurelectric_Report.pdf> accessed 27.05.2015, p.19.

	parties must make the contracted capacity available during scarcity periods, defined by an administrative body or market prices.
Capacity auctions	This is a market-wide mechanism in which total required capacity determined by an independent authority is procured through a centralised auction. Capacity auctions can be conducted year-by-year or for forward capacity. Contracted parties must make the contracted capacity available in compliance with the terms of the contract.

4.1 Capacity Payments

Capacity payments are a price-based scheme. In essence, they aim to ensure both firmness and long-term resource adequacy by attracting new investment to the system.[198] This scheme is one of the oldest solutions proposed for long term resource adequacy problems. A number of jurisdictions including Chile, Argentina, Spain, the UK, Italy, Ireland and South Korea employed or are continuing to employ capacity payment schemes in different ways to ensure long term resource adequacy. The product in a capacity payments system is generally termed firm capacity.[199] The price for firm capacity is mostly determined either fixed ex-ante by the cost of a peaking generator and ignoring VOLL, or fixed ex-post by the average disutility of the consumers pursuant to the LOLP estimated following the hourly market.[200] Each players' firm capacity represents the players' involvement to the general system's security of supply.[201]

There are two fundamental problems with this incentive mechanism. First, the reliability product traded is not reasonably defined which means that there is no requirement for generators to provide anything except a weak incentive to be available when needed.[202] Second, capacity mechanisms do not provide any guarantee regarding the desired level of

[198] BATLLE C. and RODILLA P., 'A Critical Assessment of the Different Approaches Aimed to Secure Electricity Generation Supply', *Supra* note 28, p.7122.
[199] *ibid*.
[200] FINON D. and PIGNON V., 'Electricity and long-term capacity adequacy: The quest for regulatory mechanism compatible with electricity market', *Supra* note 25, p.51.
[201] BATLLE C. and RODILLA P., 'A Critical Assessment of the Different Approaches Aimed to Secure Electricity Generation Supply', *Supra* note 28, p.7122.
[202] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34, p.601.

investment.[203] In this regard, Keay *et al.* state that "[t]he greatest problems with this approach are the significant discretion given to the regulator that can create regulatory uncertainty for investors, and the fact that administrative prices will be either too high or too low – leading either to excess investment and cost or inadequate investment."[204]

4.2 Strategic reserve

The strategic reserve scheme categorically falls into the quantity-based capacity mechanisms group. It is arguably the simplest version of a capacity mechanism. In a strategic reserve scheme, some amount of generation capacity, which is determined by an independent body such as Transmission System Operator (TSO), is put aside for ensuring security of supply in emergency situations.[205] The strategic reserve, procured typically with a one-year ahead tender, can be signalled by prices in balancing, intra-day or day-ahead markets escalating above a definite threshold level.[206] Many jurisdictions including Finland, Sweden and Norway have used the strategic reserve to ensure long-term security of supply for a long time. Belgium also, according to the Plan Wathelet, intends to establish a strategic reserve scheme only to be used when security of supply is under threat.[207]

The product procured in this mechanism is a reliability based product that does not participate in the energy market if the regulator or system operator does not regard it as necessary.[208] Contractors are nominated by centralised auctions and their sole responsibility is restricted to provide energy and capacity for markets throughout scarcity conditions (for instance, dry years).[209] This means that reserve capacity should only be entered into the

[203] *Ibid*.
[204] KEAY M., RHYS J., and ROBINSON D., 'Electricity Market Reform in Britain: Central Planning Versus Free Markets', Chapter 2 in SIOSHANSI F. (ed.), *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, 2013, p.43, pp.31-57.
[205] ACER, 'Capacity Remuneration Mechanisms and the Internal Market for Electricity', *Supra* note 197, p.5.
[206] *Ibid*.
[207] DE GEYTER A., 'The Belgian Electricity Market: Overview, Analysis of Todays Issues and Suggestions to Fix It', 20.08.2013 <http://energy.sia-partners.com/belgian-electricity-market-overview-analysis-todays-issues-and-suggestions-fix-it> accessed 09.11.2013.
[208] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34, p.611.
[209] *ibid*.

energy market at a trigger price which is equal to the VOLL.[210] Therefore, a trigger price established by a central body can be seen as an indirect price cap. Furthermore, although the function of this trigger price can be regarded as the strike price employed in reliability options, strategic reserve and reliability provide considerably different products.[211] There are two crucial differences. The first is that in a strategic reserve, generator can only participate in electricity markets if the price exceeds (or, at least, reaches) the trigger price; on the contrary, in the reliability option, generator can participate in electricity markets at any time.[212] The second difference is that reliability options require all generators to be involved, while strategic reserves require a small part of generators' involvement.[213]

4.3 Capacity obligations

Capacity obligations are another type of quantity-based capacity mechanism implemented on a decentralised basis. In other words, in this scheme each supplier or load serving entities (LSEs) and large consumers must contract for capacity at a certain level in the ratio of their self-estimated future consumption or supply requirements.[214] A central body such as the minister or the regulator in harmony with the SO determines a reserve margin according to the estimated VOLL.[215] Each supplier must show the regulator that it has adequate capacity to fulfil its peak demand plus a reserve margin determined by an administrative body.[216] Suppliers must meet their obligations through either bilateral contracting or resource ownership.[217] The reserve requirement for suppliers establishes a bilateral capacity market in

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[210] DE VRIES L.J. and HAKVOORT R.A., 'The question of generation adequacy in liberalised electricity markets', *Supra* note 69.
[211] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34, p.612.
[212] *ibid*.
[213] FINON D. and PIGNON V., 'Electricity and long-term capacity adequacy: The quest for regulatory mechanism compatible with electricity market' *Supra* note 25, p.154.
[214] ACER, 'Capacity Remuneration Mechanisms and the Internal Market for Electricity', *Supra* note 197, p. 5.
[215] FINON D. and PIGNON V., 'Electricity and long-term capacity adequacy: The quest for regulatory mechanism compatible with electricity market' *Supra* note 25, p.152.
[216] *Ibid.*
[217] PFEIFENBERGER J., SPEES K., and SCHUMACHER A., 'A Comparison of PJM`s RPM with Alternative Energy and Capacity Market Designs', The Brattle Group, Prepared for PJM Interconnection L.L.C., September 2009,

which both existing and new resources, as well as both demand-side and supply-side resources, can compete with each other on an equal basis.[218] This system is complemented by a penalty system, which fixes the penalty higher than the investment cost of a peak generator, to be charged from the supplier if it does not fulfil its commitment or from the generator if it does not have available capacity contracted with the supplier.[219]

Capacity obligation mechanisms were used in the early models of (Pennsylvania-Jersey-Maryland) PJM and New England electricity markets with the name of Installed Capacity (ICAP). In the ICAP system, each LSE had to back-up its estimated peak demand plus a reserve margin with capacity credits.[220] Although the entire installed capacity was initially rewarded with capacity credit, Independent System Operators (ISOs), beginning with PJM, then created the concept of Unforced Capacity (UCAP) in accordance with the fact that capacity is not always available.[221] In terms of the UCAP concept, ISOs discounted the capacity of each unit that authorised to sell in line with its historical availability records.[222] However, the UCAP concept did not create any new incentives for generators to be available especially in scarcity conditions, because it did not provide any positive discrimination in favour of being available during tight reserve periods.[223] Due to several design flaws such as non-recovery of investment costs, price volatility and lack of locational signals for capacity,[224] both New England and PJM replaced ICAP markets with forward capacity markets.

4.4 Capacity Markets

<https://sites.hks.harvard.edu/hepg/Papers/2009/Brattle%20RPM%20Comparison%20Whitepaper_Sept09.pdf> accessed 04.03.2018, p. 1.

[218] *Ibid*.

[219] FINON D. and PIGNON V., ‘Electricity and long-term capacity adequacy: The quest for regulatory mechanism compatible with electricity market’ *Supra* note 25, p.152.

[220] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34, p.605.

[221] BATLLE C. and RODILLA P., 'A Critical Assessment of the Different Approaches Aimed to Secure Electricity Generation Supply', *Supra* note 28, p.7174.

[222] *Ibid*.

[223] *Ibid*.

[224] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34, p.606-607.

This scheme is a quantity-based and centralised capacity mechanism to attract new generation investment and retain the existing plants in the system. This scheme can be implemented on a short-term or long-term basis. However, it should be noted that the overall tendency in the world is towards using long-term capacity auctions.

4.4.1 Short-term capacity markets

The New York Independent System Operator (NYISO) and Midwest Independent Transmission System Operator (MISO) can be shown as examples for short-term capacity markets.[225] The NYISO ICAP market is formed with a range of auctions to both procure and impose obligations for adequate UCAP to deliver reliability.[226] Auctions in the NYISO are conducted on a yearly basis to cover the need in the coming year or on a monthly basis (spot), allowing parties to adjust their buy and sell position.[227] The participation to these auctions is normally voluntary; however, LSEs that have not satisfied their obligations through centralised auctions or bilateral contracting must join spot auctions to cover their capacity market obligations.[228] In Western Australia, the Reserve Capacity Mechanism (RCM) has been established to attract sufficient investment for capacity needs. In the RCM, suppliers must secure adequate capacity either by signing bilateral contracts or by buying it from the SO at the rate of their obligation.[229] In return, generators must always be available to offer this capacity into the market unless they are undergoing planned maintenance.[230] Each year, the Independent Market Operator (IMO) is obliged to decide the Maximum Reserve Capacity Price (MRCP) which is the maximum bid price that can be offered in an auction.[231] The price of the MRCP is

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[225] PFEIFENBERGER J., SPEES K., and SCHUMACHER A., 'A Comparison of PJM`s RPM with Alternative Energy and Capacity Market Designs', *Supra* note 217, p.2.
[226] HARVEY S. M., HOGAN W. W., and HOPE S. L., 'Evaluation of the New York Capacity Market', FTI Consulting, 05.03.2013, <http://www.nyiso.com/public/webdocs/markets_operations/documents/Studies_and_Reports/Studies/Market_Studies/Final_New_York_Capacity_Report_3-13-2013.pdf> accessed 24.02.2018, p. 6.
[227] *Ibid.*
[228] *Ibid*.
[229] Independent Market Operator (IMO) Western Australia, 'Reserve Capacity: Overview', <http://www.imowa.com.au/reserve-capacity/overview> accessed 12.11.2013.
[230] *Ibid*.
[231] The Independent Market Operator (IMO), 'Final Report: Maximum Reserve Capacity Price for the 2015/2016 Year', January 2013, <http://www.erawa.com.au/cproot/11120/2/20130130%20-%20IMO%20MRCP%20Submission%20Pack.pdf>, accessed 12.11.2013, p.3.

based on the entry cost of a 160 MW Open Cycle Gas Turbine (OCGT) generation facility entering the WEM in the relevant Capacity Year.[232]

4.4.2 Long-term Capacity Markets

Among long-term capacity markets, the New England, PJM and Brazilian Electricity Markets come to the forefront. If we think of each type of CRM (discussed above) as an evolutionary step, long-term capacity markets would be the last and the most complex form. Here, it should be noted that Latin American countries pioneered the employment of auctions to solve the resource adequacy problem through long-term energy contracts of reliability.[233] Additionally, Rodilla and Batlle state that "[t]he Colombian power system pioneered the wave of change in the regulatory design of security-of-supply mechanisms and served as inspiration, directly or indirectly, for other reworked designs, (…)."[234] Furthermore, Maurer and Barroso note that the firm energy market implemented in Colombia was inspired by the New England ISO.[235] Therefore, both long term capacity markets and reliability options can be seen as two variants of the same solution.[236]

4.4.2.1 Brazil

Following a long discussion during 2002 and 2003, Brazil began to implement a new regulatory structure, or a second reform, in 2004, which gave priority to reliability of electricity supply.[237] With this reform, the government in Brazil took back the responsibility of planning and started to use long-term auctions to attract new investment and retain existing plants in the

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[232] *Ibid*.
[233] MAURER L. T. A. and BARROSO L. A., 'Electricity Auctions: An Overview of Efficient Practices', The World Bank Washington, D.C., 2011, <http://documents.worldbank.org/curated/en/114141468265789259/pdf/638750PUB0Exto00Box0361531B0PUBLIC0.pdf> accessed 04.03.2018, p. 7.
[234] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34, p.608.
[235] MAURER L. T. A. and BARROSO L. A., 'Electricity Auctions: An Overview of Efficient Practices', *Supra* note 233, p.39.
[236] For further discussion regarding similarities and differences of long-term capacity markets and reliability options, *See*, FINON D. and PIGNON V., 'Electricity and Long-Term Capacity Adequacy: The Quest for Regulatory Mechanism Compatible with Electricity Market', *Supra* note 25, p. 155.
[237] MAURER L. T. A. and BARROSO L. A., 'Electricity Auctions: An Overview of Efficient Practices', *Supra* note 233, p.34.

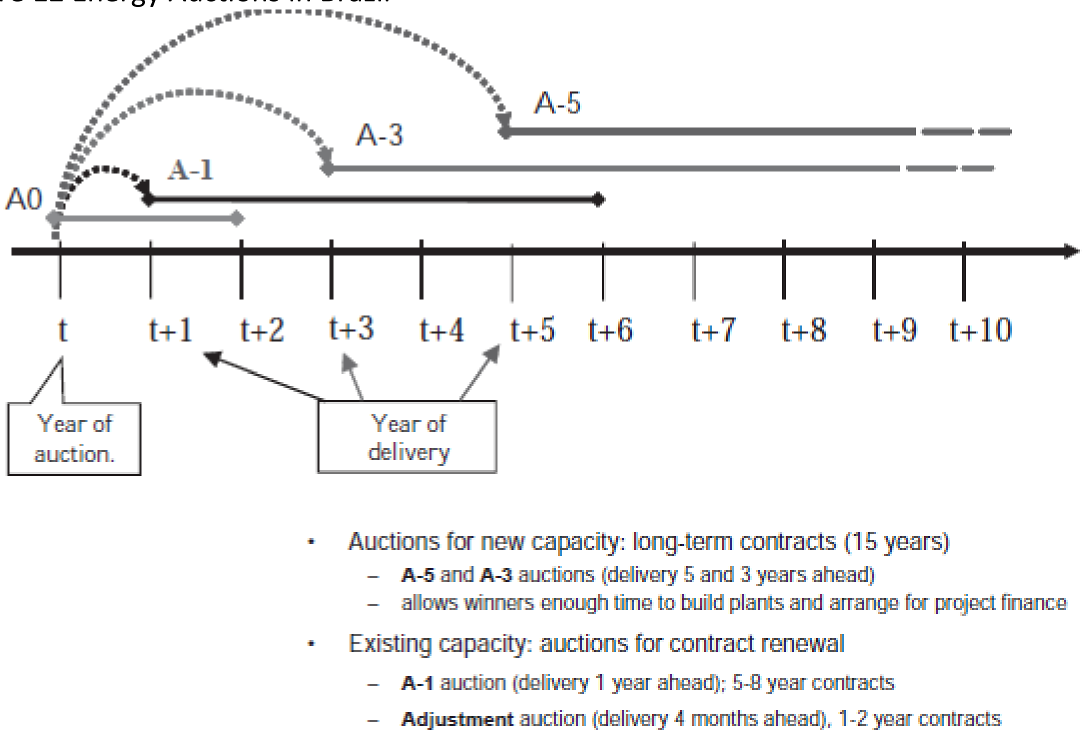
system.[238] Under the new regulatory framework, all demand including captive and free consumers must be covered by energy contracts based on Firm Energy Certificates (FEC), which represent the sustained electricity generation of each power plant once connection to the grid occurs. [239] Due to the fact that 100% demand is covered by financial energy contracts, the function of a spot energy market is to settle the negative or positive differences between the power plant's physical generation, planned by the Operator of the National Electricity System (ONS), and its contractually specified energy.[240]

The capacity market auctions in Brazil divide existing plants and new plants. While the former is rewarded with considerably shorter contract terms ranging from 5-8 to years, the latter is rewarded with longer contract terms up to 20 years for thermal plants and 30 years for hydropower plants.[241] The fundamental differences of the Brazilian case from Colombia are as follow:[242]

- As indicated above, separate auctions are held for existing and new power plants. While in the former, the lag period and commitment duration is considerably shorter, in the latter, both the lag period and commitment periods are significantly longer. (*See* Figure 12)

[238] ROSA L. P. *et al.*, 'Chapter 15 - the Evolution of Brazilian Electricity Market', in SIOSHANSI F. (ed), *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, 2013, p. 444-446. pp.435-459.
[239] MAURER L. T. A. and BARROSO L. A., 'Electricity Auctions: An Overview of Efficient Practices', *Supra* note 233, p.33.
[240] *Ibid.*
[241] ROSA L. P. *et al,* 'Chapter 15 - the Evolution of Brazilian Electricity Market', *Supra* note 238, p. 446.
[242] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34, p.610.

Figure 12 Energy Auctions in Brazil[243]



- Two reliability products are defined for different sources meaning: forward financial contracts applied for hydro power plants and an energy call option, which is mainly as the Colombian reliability options, applied for thermal plants.
- There is a backstop mechanism for the regulator to enable government to arrange specific energy auctions as a response to energy policy decisions. The auction held in 2008 for 1,200 MW of co-generated power generated with sugar cane biomass can be shown as an example of this.

Despite the fact that the capacity market in Brazil has gained considerable success so far, several concerns regarding the lack of competition and transparency during auction processes have been raised.[244]

4.4.2.2 New England: Forward Capacity Market (FCM)

[243] MAURER L. T. A. and BARROSO L. A., ‘Electricity Auctions: An Overview of Efficient Practices’, *Supra* note 233, p.34.
[244] *Ibid*., p.36.

As discussed above, New England replaced the former ICAP system with the forward capacity market. The main characteristics of the system conducted in New England are parallel to the Colombian case, although several extra features such as locational pricing and capacity requirement calculated separately for different areas are employed by the New England ISO.[245] Capacity auctions are held three years ahead of the delivery year with a one year commitment period, and the product procured in the auction is a call option supported by a physical commitment.[246] In New England, a single auction is carried out for both existing and new resources. Furthermore, a level playing field has been successfully created between demand-side sources and other technologies in auctions by the New England ISO. In other words, demand-side can equally compete with generation plants in an auction with an exception that while power plants bid for becoming available to generate electricity during the commitment period, demand side sources commit to curtail its consumption if required. Demand-side resources are expected to constitute 15% of total market needs in future when metering technologies and two-way communication provides opportunity for a significantly larger number of players to participate in the market.[247]

4.4.2.3 Pennsylvania-Jersey-Maryland (PJM): Reliability Pricing Model (RPM)

The PJM also replaced the former ICAP market with the RPM implemented in 2007 as a response to the poor performance of the ICAP market. The main elements of the RPM reforms to the earlier PJM capacity market design may be ranged as an annual market, a forward market, locational pricing for capacity, scarcity pricing by a defined demand curve which links the capacity market explicitly to the energy and ancillary services market, incentives to increase reliability and explicit market power rules involving a must offer requirement.[248] The RPM model, sharing a range of similarities with the New England ISO, is established on bidding capacity commitments three years in advance.[249] As in New England, for instance, the RPM

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[245] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34, p.611.
[246] MAURER L. T. A. and BARROSO L. A., 'Electricity Auctions: An Overview of Efficient Practices', *Supra* note 233, p.66.
[247] *Ibid*., p. 67.
[248] BOWRING J. E., 'Chapter 9 - the Evolution of the Pjm Capacity Market: Does It Address the Revenue Sufficiency Problem?', in SIOSHANSI F. (ed), *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches,* Academic Press, 2013, p.240, pp.227-264.
[249] MAURER L. T. A. and BARROSO L. A., 'Electricity Auctions: An Overview of Efficient Practices', *Supra* note 233, p.68.

conducts a single auction for both existing and new sources and also uses locational capacity pricing to reflect transmission constraints and detect locational capacity requirements. Furthermore, the demand side participation to capacity auctions has been very successfully conducted so far. The crucial difference of the RPM from the New England ISO is about defining the reliability product. While in New England the reliability product is defined in line with the Colombian case, the RPM defines it as a variation of UCAP by measuring availability in a more detailed manner, and with longer lag (three years) and commitment (one year) periods than the UCAP system.[250]

4.2.3 Reliability Options: The Colombian Case

Roughly speaking, a reliability option is a kind of call option that is generally contracted through centralised auction. The auction is organised to determine the strike price, which behaves as a market compatible price cap, time horizon, total amount of power to be purchased and the penalty regime.[251] The main difference of the reliability option from a standard call option is that it includes a physical delivery obligation to increase the availability of generation when required.[252] This mechanism includes two time-related parameters: lag period (or, lead time) and commitment duration. For the former, providing a sufficient lag period is crucial to allow new power plant to be constructed and for the latter, defining a proper commitment duration is also vital to decrease risk and hence enhance project financing.[253]

Following the use of the capacity payment model between 1996 and 2006, to overcome its shortcomings, Colombia introduced a new regulatory structure based on a reliability option scheme called the Firm Energy Market implemented in 2008.[254] In this scheme, generators are paid with a reliability charge based upon the results of auctions for Firm Energy Obligation

[250] RODILLA P. and BATLLE C., 'Security of Generation Supply in Electricity Markets', *Supra* note 34, p.611.
[251] *İbid*., p.618.
[252] *Ibid*., p.617.
[253] *Ibid*.
[254] MAURER L. T. A. and BARROSO L. A., ‘Electricity Auctions: An Overview of Efficient Practices’, *Supra* note 233, p.39.

in lieu of a guarantee to supply energy at a fixed price whenever spot prices surpass the pre-determined "Scarcity Price" which is estimated on a monthly basis by the Colombian Regulatory Authority (CREG) in accordance with the Fuel Price Index.[255] Two auctions were conducted in 2008 in Colombia, and commitment periods ranged from 1 to 20 years in accordance with whether it is a new or existing resource.[256] While the first auction had a fixed 4.5 years lag period, the second auction was held for plants that require longer construction times. The reliability option market is accepted as a very successful case. Furthermore, according to sector specialists, the continuing success of the reliability option market is based on a competitive environment for new entrants with low entry barriers and a constant regulatory structure during the lifetime of new plants.[257] However, Harbord and Pagnozzi criticised the Colombian case from two aspects: short lag period and holding two auctions for different sources.[258] Thus, it is suggested that the use of a single auction covering a longer lag period may result in more competition and efficiency.

4.5 Discussion

Each type of CRM has its own advantages and disadvantages. To reveal these pros and cons, many studies have been conducted. These studies have been generally based on cost-benefit analysis for each type of CRMs, and various criteria have been employed to evaluate each scheme from different perspectives (*See* Table 4). Although suggesting a one-size-fits-all policy is obviously impossible, it is safe to say that most studies have agreed that using forward capacity markets is by and large the better option. There are various design elements for forward capacity markets changing case by case in terms of requirements. Herein, Ausubel and Cramton noted that "[o]ur view is that forward markets can address three of the pressing problems in current wholesale markets: investment, risk and market power."[259] Likewise, Joskow argued that "if properly designed, forward capacity markets can act as a safety valve

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[255] *Ibid*.
[256] *Ibid*., at p. 40.
[257] *Ibid*., at p.44.
[258] HARBORD D. and PAGNOZZI M., 'Review of Colombian Auctions for Firm Energy', 25.11.2008, <http://www.market-analysis.co.uk/PDF/Reports/ColombianOEFAuctionsReport-25-11-08%20Final.pdf> accessed 29.11.2013, p.29.
[259] AUSUBEL L. M. and CRAMTON P., 'Using Forward Markets to Improve Electricity Market Design', *Supra* note 86, p.195.

to fill the net revenue gap and support efficient investment in generation and demand response, are compatible with the continued evolution of retail competition, and can help to reduce investor concerns about price volatility."[260] Examples can be further extended; however, based on the research undertaken for the purpose of this research, Table 4 below provides a clear comparison of many aspects of CRMs.

Table 4 Comparison of CRMs

CRMs → *Criteria* ↓	**Strategic Reserve**	**Capacity Payment**	**Capacity Obligation**	**Short-term Capacity Market**	**Forward Capacity Market/Reliability Options**
Efficiency of resource adequacy target	- Too hard to calculate the correct amount of reserve capacity and trigger price - No aim to attract new investment	Doubtful due to two weaknesses - Absence of obligation - Indirect effect on reliability	Lower performance than expected in meeting resource adequacy	Providing no adequate time to attract new investment	Efficient to meet resource adequacy target
Compatibility with energy market	Not compatible with energy market by its nature	-	-No clear link in the short term -Double payment problem	-No clear link in the short term -Double payment problem	-No clear link in the short term -Double payment problem; however, in the reliability option this problem could be overcome with strike price
Transparency	-	Tending to be non-transparent and increasing regulatory risk	Potentially a high lack of transparency	More transparent via central auctions	More transparent via central auctions
Exercising market power	Trade-off between higher	Open to manipulativ	Hard to monitor and mitigate	Facilitating monitoring and	Facilitating monitoring and

[260] JOSKOW P.L., 'Competitive Electricity Markets and Investment in New Generating Capacity', *Supra* note 83, p. 49

	trigger price and mitigation of market power	e strategic behaviour	market power due to bilateral market structure with low transparency	mitigation of market power	mitigation of market power
Incentive to be available	Only on reserves	No adequate incentive to be available	Possible to mask unavailability with high priced bid, despite the must-offer requirement	-	In particular reliability options are designed to provide incentives to increase availability
Regulatory level in investment decisions	Reserve investments determined by a central body (i.e. TSO)	Leaves market mechanism the timing and type of investment with additional revenue	Leaves market mechanism the timing and type of investment with additional revenue	Using central auctions to purchase new capacity	Using central auctions to determine time of investments
Price Stability	Trade-off between higher trigger price and price stability	Improve price stability if combined with a price cap	Highly volatile prices	-	Robust for price stability
Compatibility with interdependent electricity markets	Not compatible with open markets, if there is enough interconnec tion	No guarantee against capacity shortage in neighbour markets	Not compatible with open markets, if there is enough interconnectio n	-	Robust in interconnected electricity markets

Source: Prepared by the author based on the studies: (De Vries 2007; Finon and Pignon 2008; Batlle and Rodilla 2010; Pfeifenberger *et al.* 2009; Finon and Roques 2013; Pablo Rodilla and Batlle 2013)

5. Conclusion

This chapter provided a general Conceptual Framework for CRMs. It answered the question of why CRMs may be required in energy-only markets to ensure generation adequacy. In summary, the chapter discussed the main electricity market imperfections that are obstacles for well-functioning energy-only markets. In this section, both theoretical and practical issues were examined in order to illustrate the imperfections of the electricity market. Consequently, these imperfections were ordered as follows: Public good characteristics of generation adequacy; the missing money problem; the boom-and-bust cycle and lack of forward markets. In light of the literature discussed and analysed here, the causes of each imperfection were assessed one by one and the consequences of these were revealed. Consequently, the types of CRMs were studied briefly, with examples taken from around the world.

The Conceptual Framework provided in this chapter will serve as a reference point for the next section of the thesis, Chapter 3. Thus, it will allow to make a comparison between the reasons for the establishment of CRMs that this Conceptual Framework revealed, and the justifications for CRMs established in the European electricity markets. In addition, the types of CRMs examined individually at the end of this chapter will facilitate an understanding of the CRMs established in European electricity markets.

CHAPTER 3 - CAPACITY REMUNERATION MECHANISMS IN EUROPEAN ELECTRICITY MARKETS

1. Introduction

In recent years, the majority of articles on European electricity markets feel the need to highlight the point that they are in a major transition process. Certainly, the question of what this huge transition is has no easy answer since energy transitions may have different meanings for different countries or different timeframes. Transition as a word can be defined as "a change from one form or type to another, or the process by which this happens."[1] By their nature, all kinds of transitions, including energy transitions, create challenges to be overcome. This is natural because all transitions, more or less, must aim to change a kind of *status quo*. It is a well-known fact that one of the primary features of any *status quo* is their resistance to changes/transitions. So, it can be argued that energy transitions as a form of major transformation aims to change the current *status quo* in the energy sector based on mainly fossil-fuel inputs with highly centralized structure to a low carbon and decentralized structure. In this sense, it is important to define the concept of energy transitions. Some researchers and institutions have attempted to define it. For instance, Smil argued that even though there is no commonly accepted definition of the concept of energy transitions, it is mainly described as "the change in the composition (structure) of primary energy supply".[2] Further, Mersinia and Penttinen defined this concept as a process "that the energy system is required to undergo in order to meet the challenges posed, in particular, by the man-made greenhouse gases attributable to the energy sector.[3] In a similar way, Arent et al indicated that the notion of energy transitions widely means the replacement of current technologies and related energy inputs throughout all energy industries both at the levels of intermediates

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[1] Cambridge Dictionary, 'Transition', <https://dictionary.cambridge.org/dictionary/english/transition> accessed 09.10.2018.

[2] SMIL, V., *Energy Transitions: History, Requirements, Prospects,* Praeger, Oxford, 2010, p. VII.

[3] MERSINIA, I. and PENTTINEN, S.L., 'Introduction: Examining Different Aspects of the Energy Transition', in PENTTINEN, S.L. and MERSINIA, I. (eds.), *Energy Transitions: Regulatory and Policy Trends*, Volume 5, Intersentia, UK, 2017, p.1, pp. 1-7.

and final goods.[4] Furthermore, in one of its reports, World Energy Council (WEC) defined energy transitions as a fundamental structural changes of the energy industry occurring around the world without any exception.[5] European electricity markets are experiencing the challenging consequences of this paradigm-shift transition, largely prior to that of the rest of the world's electricity markets. This reality is best expressed in the World Energy Outlook (WEO) 2016 of the IEA: "The speed and depth of the projected transition to new renewable energy sources in power generation in the EU makes it a living laboratory for other large economies seeking to ramp up variable renewable generation, including China and the United States."[6] The rapid proliferation of CRMs across Europe can be regarded as a natural part and/or consequence of this transition. Naturally, this rapid proliferation has created its own challenges to be overcome. Before coming to these challenges and possible regulatory options to overcome them, this chapter will examine the conditions for the rise of CRMs across Europe.

In the previous chapter, a general overview regarding the question of why CRMs may be required in energy-only markets was presented. In addition to the basic motivations behind the establishment of CRMs, different types of CRMs were analysed utilising a range of cases from around the world. This chapter will serve to act as an introductory chapter to CRMs in the context of the EU Electricity Markets. First, it handles the historical background of the Internal Electricity Market (IEM), and analyses why most European countries cannot solve generation adequacy concerns without establishing CRMs in their jurisdictions. Further, this chapter will put forward several reasons/challenges for the establishment of CRMs in the EU. These challenges are divided into two groups: (1) *Challenges Compatible with the Conceptual Framework:* Here, challenges that lead to the establishment of CRMs around the world, as suggested by the Conceptual Framework set out in Chapter 2, are examined. In this sense, the missing money problem and rising share of RESs in European Electricity Markets are handled

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[4] ARENT, D. et al., 'Introduction and Synthesis', in ARENT, D., ARNDT, C., MILLER, M., TARP, F. and ZINAMAN, O. (eds), *The Political Economy of Clean Energy Transition,* Oxford University Press, UK, p.3, pp. 3-15.

[5] HAUFF, J. et al., 'Global Energy Transitions: A comparative analysis of key countries and implications for the international energy debate', World Energy Council and Atkearney, 2014, <https://www.atkearney.com/documents/10192/5293225/Global+Energy+Transitions.pdf/220e6818-3a0a-4baa-af32-8bfbb64f4a6b> accessed 10.10.2018.

[6] IEA, 'World Energy Outlook 2016', OECD/IEA, Paris, 2016, p.272.

as the first and main reasons for CRMs in the EU; (2) *The European-centric reasons for increasing generation adequacy concerns:* This section will observe the challenges unique to the EU that led to the types of CRMs found in the EU. In this context, low carbon prices – failure of Emission Trading Scheme (ETS Scheme), phasing out nuclear and coal power plants, flood of cheap shale gas and the World Financial Crisis 2008 – are examined, respectively. At the end of the Chapter, 12 Member States that have established or intend to establish a CRM are presented in a table.

2. Process of the formation of an Internal Electricity Market for Europe

Creating a proper internal market[7] has always been a central objective for the EU since its earliest days. Ever since the first agreement was concluded, the 'Founding Treaties'[8] of the EU including the Treaty of Paris (1951), the Treaty of Rome (1957), the Treaty of Maastricht (1992) and the Treaty of Lisbon (2007) have insistently emphasised the importance of a well-functioning internal market.[9] For instance, Article 2 of the Treaty of Paris reads that "[t]he mission of the European Coal and Steel Community [ESCS] is to contribute to economic expansion, the development of employment and the improvement of the standard of living in the participating countries through the institution […] of a common market […]."[10] In line with this, Article 2 of the Treaty of Rome notes that

> "[t]he Community shall have as its task, by establishing a common market […], to promote throughout the Community a harmonious development of economic

[7] Throughout the history, the terms "common market", "single market" and "internal market" have been interchangeably used in various legal documents and academic works in the context of the European integration. To the best of our knowledge, there is no clear distinction among these terms in terms of their meaning. Therefore, the term "internal market" is here used within the same meaning of the term "single market" and "common market". For a brief discussion about these terms, *See,* MORTELMANS K., 'The Common Market, the Internal Market and the Single Market, What's in a Market?', (1998) 35 *Common Market Law Review*, pp. 101-136.

[8] The term "Founding Treaties" is used by the EU on its official website. *See*, EUR-LEX Access to European Union Law, 'Founding Treaties' <http://eur-lex.europa.eu/collection/eu-law/treaties/treaties-founding.html> accessed 25.02.2018.

[9] These treaties are analysed more broadly below.

[10] Treaty establishing the European Coal and Steel Community (ECSC Treaty), <http://www.consilium.europa.eu/uedocs/cmsUpload/Treaty%20constituting%20the%20European%20Coal%20and%20Steel%20Community.pdf> accessed 25.02.2018.

> activities, a continuous and balanced expansion, an increase in stability, an accelerated raising of the standard of living and closer relations between the States belonging to it."[11]

As Founding Treaties of the European Union, relatively recent Treaties such as the Treaty of Maastricht and the Treaty of Lisbon have aimed to establish a properly functioning internal market to increase the well-being of the European citizens. Of course, the Treaty and/or European institutions have become far more complex over time, yet establishing the internal market has always been a primary and indispensable priority for all EU activities.[12]

2.1 Historical Background

After the catastrophic effects of the Second World War, a collapsed Europe had to make a clean start to bind up wounds and enliven the economic situation in Europe. The Founding Fathers[13] of the EU thought that the reinvigoration of Europe following the Second World War could only be realised so long as European countries acted in solidarity. To manage this, integration among European countries was perceived as a necessity.

For many researchers, the history of integration of the European countries dates to the early 1950s. This approach is right in many aspects since all founding agreements and intergovernmental institutions came into existence after 1950. Yet it should be noted that the idea, cultural codes, shared history of Renaissance and Reform Movements and philosophical accumulation concerning European integration go back hundreds, even thousands of years.

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[11] EUR-LEX Access to European Union Law, 'Treaty of Rome' <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV%3Axy0023> accessed 25.02.2018.

[12] J. PELKMANS, 'Why the single market remains the EU's core business', (2016) 39:5 *West European Politics*, pp. 1095-1113.

[13] As a well-known fact that the term "Founding Fathers" is generally referred to the founders of the US, George Washington, John Adams, Benjamin Franklin, Thomas Jefferson, James Madison, Alexander Hamilton and James Monroe. In analogy to the US, the EU also in its official website declares its Founding Fathers as follow: Konrad Adenauer, Joseph Bech, Johan Willem Beyen, Winston Churchill, Alcide De Gasperi, Walter Hallstein, Sicco Mansholt, Jean Monnet, Robert Schuman, Paul-Henri Spaak and Altiero Spinelli. *See* European Union, 'The Founding Fathers of the EU', <https://europa.eu/european-union/about-eu/history/founding-fathers_en> accessed 21.09.2016.

Countless European philosophers, authors, artists and politicians thought over the issue of European unity. Here, providing some examples can be useful to understand just how old the idea of a single Europe is.

A well-known text regarding the unity of Europe was put forward by Victor Hugo, one of the most famous and influential French authors in history and who directly faced a torrid time due to long periods of war in his age, at the Paris Peace Congress in the middle of 19th Century:

> "A day will come when your arms will fall from your hands! A day will come when war will seem as absurd between Paris and London, between Petersburg and Berlin, between Vienna and Turin, as it would today between Rouen and Amiens or between Boston and Philadelphia. A day will come when you — France, Russia, Italy, England, Germany — all you nations of the continent will merge, without losing your distinct qualities and your glorious individuality, in a close and higher unity to form a European brotherhood…
>
> A day will come when the only fields of battle will be markets opening up to trade and minds opening up to ideas. A day will come when bullets and bombs will be replaced by votes, by universal suffrage of the peoples, by the venerable arbitration of a great sovereign senate which will be to Europe what Parliament is to England, […] what the Legislative Assembly is to France. A day will come when we will display cannon in museums just as we display instruments of torture today, amazed that such things could ever have been. […]"[14]

[14] Victor Hugo stated these words, as mentioned above, at the Paris Peace Congress in the middle of 19th Century. This text is directly taken from the following source of V. Reding (served as the Vice-president of the European Commission between 2010 and 2014 and currently serving as a Member

Another example is provided by the Economist: "[e]ver since the fall of Rome, a strain in European thought has longed for the re-creation of an over-arching political structure for Europe, and used the Roman empire as a model."[15] In addition to these quotations, others go back to the second half of the 15th Century for the idea of a unified Europe, at the time of the conquest of Constantinople (today called as İstanbul) when the European nations had come together against the Ottoman Empire as their major enemy.[16] Moreover, Majone found the root of European unity in the Westphalia Agreement (1648)[17] and the French Revolution (1789).[18] According to Majone, at that time the European countries had a type of cultural, economic and political unity which did not exclude frequent wars and the unity of empire but included a system where states compete and cooperate with each other.[19] He called this as "unity in diversity".[20] In any case, the idea of creating a single Europe have inspired many people including bloody-minded dictators such as Hitler, philosophers such as Immanuel Kant and authors such as Victor Hugo throughout a long history.[21] Of course, the dream of all these people was not the same, with the exception of the core idea of European unity. Vataman, in this regard, noted that "[t]he idea of a united Europe is old and deeply rooted in the history of European continent, these taking different forms over the passage of time."[22]

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of the European Parliament): REDING V., 'Why we need a United States of Europe now', Press Release, 08.11.2012, <http://europa.eu/rapid/press-release_SPEECH-12-796_en.htm> accessed 26.09.2016.

[15] The Economist, 'European unity: The history of an idea', 30.12.2003, <http://www.economist.com/node/2313040> accessed 26.09.2016.

[16] HAVEL V., *Dreaming Aloud* in COLEMAN J. (ed), 'The Conscience of Europe', Council of Europe Publishing, Strasbourg, 1999, pp. 89-97 *cited in* SHUANGGE W., *Shareholder Primacy and Corporate Governance: Legal Aspects, Practices and Future Directions,* Routledge Taylor & Francis Group, London and New York, 2013, p.109.

[17] The Westphalia Agreement (or, the Peace of Westphalia) was signed in 1648 so as to finish the famous Thirty Years War, which was one of the most devastating wars in Europe history. *See,* GROSS L., 'The Peace of Westphalia 1648-1948', (1948) 42 *The American Journal of International Law*, pp. 20-41.

[18] MAJONE G., 'From Community to Diverse Union', *Dilemmas of European Integration: The Ambiguties and Pitfalls of Integration by Stealth*, Online Publication, Oxford Scholarship Online, 2005, p.2.

[19] *Ibid.*

[20] *Ibid.*

[21] The Economist, 'European unity: The history of an idea', *Supra* note 15.

[22] VATAMAN D., 'History of the European Union', (2010) *Lex ET Scientia International Journal*, Vol. 17, Issue 2, pp. 107-137. Vataman in this article embraces the question of what kinds of different

Interestingly (or, may be naturally), the idea of a single Europe has generally gained strength in or after times of war. Against a common enemy or to prevent a war within the continent, creating European unity has always been an attractive inspiration. Indeed, at the end of the day, the Second World War, the biggest war ever seen, basically motivated the establishment of the EU. This reality is put into words by the EU itself by saying that: "The [EU] is set up with the aim of ending the frequent and bloody wars between neighbours, which culminated in the Second World War."[23]

This part of the study will deal briefly with ideas concerning the integration of European countries before 1950. Surely, this is an extremely complex and long issue to write in a few pages. Beyond doubt, a broad range of different academic disciplines including history, political sciences, international law have examined this issue in numerous books, articles, reports and notes. However, it is clear that not attempting to answer this question in this study will affect the ability to understand the issues in the coming section: this author strongly believes that a focus only on the period after 1950 to understand the concept of European integration will result in missing crucial factors in comprehending how the future integration process (in the context of this study, the integration of European electricity markets) may evolve. After this introduction, the question of how the Internal Market in Europe has been progressed since the early 1950s will be briefly analysed before examining the IEM.

forms of unity have been tried throughout the history in Europe. However, this issue is well out of area of this chapter. Therefore, this topic is not handled here anymore.

[23] European Union, 'The History of the European Union' <https://europa.eu/european-union/about-eu/history_en> accessed 25.02.2018.

2.2 Towards the Internal Market

European integration started with the method of economic integration[24] which can be realised by removing economic borders between two or more jurisdictions.[25] In this sense, the first concrete step to establishing a European internal market was taken at the beginning of the 1950s.[26] The Treaty establishing the ECSC (Treaty of Paris), adopted in 1951, created

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[24] Economic integration can be established at a range of different levels such as Free Trade Area, Customs Union, Common Market, Economic Union and Total Economic Integration. These levels differentiate from each other in terms of harmonization levels of institutions among relevant countries. For instance, while only tariffs and quotas are a matter of economic integration in the form of Free Trade Area, the form of Total economic integration regulates even fiscal, social and monetary policies of member states through supranational institutions. Because this issue is well out of area of this chapter, no more explanation will be made here. However, it should be noted that the type of European economic integration mostly resembles to the form of total economic integration. For more information, *See*, BALASSA B., 'The Theory of Economic Integration', Irwin, Homewood, I11, 1961, *cited in* PELKMANS J., *European Integration: Methods and Economic Analysis*, (Third Edition), Pearson Education, England, 2006, p.7.

[25] PELKMANS J., *European Integration: Methods and Economic Analysis*, *Supra* note 24, p.2.

[26] Properly speaking, there were other initiatives before 1950. For instance, the Treaty established the Benelux Union was first signed by three governments-in-exile in London in 1944 and came into force in 1948. Benelux is a political economic union that was established among three neighbouring countries including Belgium, the Netherlands and Luxembourg. The name of the Benelux is coming from the first letters of the member countries. This Treaty established a Customs Union among these countries. In 1958, these three countries signed a new Treaty in order to establish the Benelux Economic Union and this Treaty came into force in 1960. The Benelux is accepted as one of the first initiatives to reconstruct Europe in post-World War 2 (WW2) situation. In this regard, it is not wrong to claim that it contributed the establishment of the EU. As another example, in 1948, the Treaty of Brussels (Treaty of Economic, Social and Cultural Collaboration and Collective Self-Defence) was concluded among the UK, France, Belgium, the Netherlands, Luxembourg. Hereby, the Brussels Treaty Organization (or, Western European Union) was established. Article 1 of this Treaty mentioned some economic objectives such as economic recovery of Europe and economic coordination among the High Contracting Parties. However, in accordance with the general acceptance, the primary aim of this Treaty was to constitute a common defence policy against the possibility of renewal of the aggression policy of Germany. For instance, the Preamble of the Treaty reads that "[t]o take such steps as may be held to be necessary in the event of a renewal by Germany of a policy of aggression". Furthermore, Article 4 of the Treaty clearly indicated that "If any of the High Contracting Parties should be the object of an armed attack in Europe, the other High Contracting Parties will, in accordance with the provisions of Article 51 of the Charter of the United Nations, afford the Party so attacked all the military and other aid and assistance in their power." The Treaty of Brussels is also accepted as pioneer of the North Atlantic Treaty (the Treaty of Washington), signed in 1949, established the North Atlantic Treaty Organization (NATO). *See* CVCE.EU, 'Benelux', <http://www.cvce.eu/en/education/unit-content/-/unit/02bb76df-d066-4c08-a58a-d4686a3e68ff/02d476c7-815d-4d85-8f88-9a2f0e559bb4> accessed 27.09.2016; NATO, 'The Brussels Treaty', <http://www.nato.int/cps/en/natohq/official_texts_17072.htm> accessed 23.09.2016; ENCYCLOPEDIA.COM, 'Treaty of Brussels', <http://www.encyclopedia.com/topic/treaty_of_Brussels.aspx> accessed 23.09.2016.

the ECSC, which was in force from 1952 to 2002. This treaty established a common market for two strategic sectors, coal and steel, between six signatory countries including France, Germany, Italy, Belgium, Luxembourg and the Netherlands. The ECSC was regarded as crucial to renormalise the hostile relations between especially France and Germany, inherited from the Second World War, and to create a political unity to succeed economic reconstruction.[27] Further, the ECSC paved the way for two other treaties, the Euratom Treaty establishing the European Atomic Energy Community and the Treaty of Rome establishing the European Economic Community (EEC), signed in 1957. The European Atomic Energy Community (EURATOM) Treaty was initially signed to coordinate research programmes between Member States to use nuclear energy in a peaceful manner. Today, it provides a framework for pooling knowledge, infrastructure and funding for nuclear energy, and ensuring security of atomic energy supply under a centralised monitoring system.[28] France, Germany, Italy and the Benelux countries came together with the EEC Treaty in 1957 for the purpose of achieving integration through the elimination of trade barriers so as to enhance economic expansion. The EEC evolved into the EU with several changes until the Treaty of Lisbon in 2007. Table 5 below sets out the main treaties with regard to the formation of the Internal Market.

[27] TALUS K., *The Regulatory History of EU Energy*, Oxford University Press, 2013, p.15-16.
[28] EUR-LEX Access to European Union Law, 'Treaty establishing the European Atomic Energy Community (EURATOM)' <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV:xy0024> accessed 25.02.2018.

Table 5 Main Treaties for the Formation of the Internal Market[29]

Year	*Treaty*	*Content*
1951	Treaty establishing the ECSC – Treaty of Paris	Signed by France, Germany, Italy, Belgium, Luxembourg and the Netherlands to create the ECSC. Its main purpose was to create interdependencies among signatory countries for two strategic sectors. It was a critical and first step to reduce the tensions inherited from the Second World War. Entered into force in 1952 and expired in 2002.
1957	Treaties of Rome – EEC and EURATOM Treaties	With the Treaties of Rome, two institutions, the EEC and EURATOM, were established. - In the EEC Treaty, France, Germany, Italy and Benelux countries came together to establish a common market, a customs union and to develop common policies in areas such as agriculture (Articles 38 to 47), trade (Articles 110 to 116) and transport (Articles 74 to 84). Entered into force in 1958. - The same signatory countries with the EEC Treaty concluded the EURATOM Treaty. The main objective of this Treaty was initially to coordinate nuclear energy research programmes for peaceful purposes in a safe manner. Nuclear

[29] EUR-LEX Access to European Union Law, 'Treaty of Rome', *Supra* note 11; EUR-LEX Access to European Union Law 'Treaty establishing the European Atomic Energy Community (EURATOM)', *Supra* note 28; SAVAŞAN Z., 'A Brief Overview on EU Institutional Change from Foundation to Lisbon', (2012), II *Ankara Avrupa Çalışmaları Dergisi*, pp.61-84, <http://dergiler.ankara.edu.tr/dergiler/16/1675/17872.pdf> accessed 29.09.2016; EUR-LEX Access to European Union Law, 'The Single European Act' <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=URISERV%3Axy0027> accessed 25.02.2018; European Parliament, 'The Maastricht and Amsterdam Treaties', <http://www.europarl.europa.eu/atyourservice/en/displayFtu.html?ftuId=FTU_1.1.3.html> accessed 25.02.2018; European Commission, 'Summary of the Treaty of Nice', Press Release, 31.01.2003, <http://europa.eu/rapid/press-release_MEMO-03-23_en.htm> accessed 25.02.2018 ; EUR-LEX Access to European Union Law, 'The Treaty of Lisbon' <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:ai0033> accessed 25.02.2018.

		energy was accepted as a tool to reduce the dependence of signatory countries on conventional energy sources. Currently, the EURATOM Treaty is employed to "pool knowledge, infrastructure and funding of nuclear energy" and it is still in force.
1965	Merger Treaty – Brussels Treaty	Signed in 1965 and entered into force in 1967. It can be accepted as one the main early institutional changes in the EU history. With this treaty, two main institutions, a Single Commission and a Single Council, were established to serve the three different Communities including the ECSC, the EEC and EURATOM.
1986	Single European Act (SEA)	Signed in 1986 and entered into force in 1987. It was the first major amendment to the EEC Treaty. Its main aim was to accelerate the integration process of the European countries and complete the Internal Market. The SEA increased the ruling power of the European institutions, especially for the areas of research and development, environment and foreign policy. The SEA set forth to turn the Common Market into a Single Market by 1993.
1992	Treaty on the European Union (TEU) – Maastricht Treaty	Signed in 1992 and entered into force in 1993. The TEU has the characteristic of being the first agreement on the EU. With this agreement, the name of the EEC was officially changed into the EU. It initiated a new phase in the integration process of the European countries: Political integration.
1997	Treaty of Amsterdam	Signed in 1997 in Amsterdam to amend the TEU. Entered into force on 1 May 1999. It increased the powers of the Union, provided a stronger position for the European Parliament, contained provisions

		regarding cooperation among Member States under certain conditions and provided other issues such as institutional reforms concerning enlargement.
2001	Treaty of Nice	Signed on 26 February 2001 and entered into force on 1 February 2003. It aimed to prepare the European institutions for enlargement of the EU towards eastern Europe.
2007	Treaty of Lisbon	Signed on 13 December 2007 and entered into force 1 December 2009. It aimed to adapt the function and decision-making processes of the European institutions for the enlarged EU with 28 Member States. In this regard, the Lisbon Treaty contained provisions concerning: (1) reforming the EU institutions and strengthening the decision-making process of the EU, (2) improving the democratic dimension of the EU, (3) reforming the internal policies, (4) strengthening the external policies of the EU.

All the treaties expressed above have more or less served to establish the EU Internal Market by providing economic, cultural, social and political integration of the European countries. Among several dimensions of the European integration, energy has always been a key area throughout the history of the EU. Within the context of this thesis, electricity is the main subject; therefore, in the following section, integration of the EU electricity markets is briefly analysed.

2.3 What is the Internal Electricity Market?

As can be seen from the developments discussed above, energy has clearly had a central role in the history of European integration. However, this does not mean that there has always been a common European energy policy since the 1950s. As noted by Talus, there was no common European energy policy until the late 1980s, despite two of the founder treaties

(ECSC and EURATOM) directly concerning energy issues.[30] It could be said that a proper common European energy policy was started to liberalise European energy markets in the beginning of the 1990s. Since the early 1990s, European countries have tried to achieve three main objectives: the competitive and affordable, environmentally sustainable and secure supply of energy for each citizen in the EU.[31] Creating a well-integrated internal energy market has always been regarded as a precondition to realise these aims. This is true for both the gas and electricity industries. Therefore, reforms in both these sectors have been – more or less – collaterally made in the EU. However, as this thesis deals with electricity markets, this study will analyse the reforms made in the electricity market rather than the gas market.

Liberalisation in the European electricity markets began in the early 1990s as a result of decreased political concerns regarding security of supply.[32] At that time, with the end of the Cold War, Russia could provide gas in a less risky environment for liberalisation-favoured gas-fired power plants.[33] Furthermore, the initial surplus generation capacity around Europe helped to catalyse electricity market liberalisation.[34]

Initially, liberalisation in electricity markets in Europe started in the UK and followed by Norway. It is not wrong to say that the structure of liberalisation in the UK served as a model for the rest of the European countries.[35] This model was also taken by the Commission as a starting point. The Commission enacted several Directives to centralise liberalisation movements in Europe and required Member States to adopt certain sets of rules within certain deadlines toward the liberalisation of national electricity markets.[36] Hence, it could be

[30] TALUS K., *The Regulatory History of EU Energy*, *Supra* note 27, p.21.
[31] European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, 'Progress towards completing the Internal Energy Market', COM(2014) 634 final, Brussels, 13.10.2014, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0634&from=EN> accessed 26.02.2018, p.2.
[32] JAMASB T. and POLLITT M., 'Electricity Market Reform in the European Union: Review of Progress toward Liberalization & Integration', *The Energy Journal*, Vol. 26, Special Issue: European Electricity Liberalisation, (2005), p. 6. and TALUS K., *The Regulatory History of EU Energy*, *Supra* note 27, p.19.
[33] JAMASB T. and POLLITT M., 'Electricity Market Reform in the European Union: Review of Progress toward Liberalization & Integration', *Supra* note 32, p. 6.
[34] *ibid.*
[35] NEWBERY D., *Privatization, Restructuring and Regulation of Network Utilities,* The MIT Press, London, 3rd ed., 2002, p.199.
[36] JAMASB T. and POLLITT M., 'Electricity Market Reform in the European Union: Review of Progress toward Liberalization & Integration', *Supra* note 32, p. 6.

said that electricity markets in each Member States have been basically shaped through a central authority held in Brussels. In this sense, liberalisation of electricity markets in Europe went hand-in-hand with three Electricity Directives (1996, 2003 and 2009, respectively). So, the current electricity market structure in the EU Member States is shaped a by virtue of these three Directives, as portrayed in Table 6 (below).

Table 6 Cornerstones of Electricity Market Liberalisation in the EU[37]

	Most common form pre-1996	**1996 Directive**	**2003 Directive**	**2009 Directive**
Generation	Monopoly	Authorisation Tendering	Authorisation	Authorisation
Transmission and distribution	Monopoly	Regulated [Third Party Access] TPA Negotiated TPA Single buyer	Regulated TPA	Regulated TPA
Supply	Monopoly	Accounting separation	Legal separation from transmission and distribution	Ownership separation from transmission and distribution Legal separation from transmission and distribution under ISO/ITO arrangements

[37] VASCONCELOS J., 'Services of general interest and regulation in the EU energy market,' (2004), CEER Presentation at XVI CEEP Congress, Leipzig, *cited in* STAGNARO C., *Power Cut? How the EU is pulling the plug on electricity markets,* 2015, The Institute of Economic Affairs (IEA), London, p. 61. This table includes Stagnaro's additions on Vasconcelos' table.

Customers	No choice	Choice for eligible customers	All non-household consumers have choice (2004) All consumers have choice (2007)	All consumers have choice
Unbundling transmission and distribution	None	Accounts	Legal	Ownership Legal under ISO/ITO
Cross-border trade	Monopoly	Negotiated	Regulated	Regulated
Regulation	Government department	Not specified	Independent regulatory body	Independent regulatory body

Table 6 above provides a general picture of the legislative framework in regard to liberalisation of the EU electricity market since 1990s. Within the context of this thesis, the legal framework established by Electricity Directive 2009 for generation investments and cross-border electricity trade is relevant. In this sense, relevant provisions of Electricity Directive 2009 are broadly examined in Chapter 4 under the subheading of 3.1.1 Legal Framework for CRMs in the EU. Therefore, no more discussion or explanation is made here about the legislative history concerning the liberalisation of EU Electricity Market.

3. The Birth of Capacity Remuneration Mechanisms in the EU Electricity Markets

The previous part of this chapter dealt with the historical background of electricity market reforms in EU electricity markets. It is known that a Target Model for the EU electricity markets has been envisaged since the beginning of liberalisation movements. Electricity Directive 2009 was entered into force to complete this Target Model. So, the current electricity market structure in the EU is based on Electricity Directive 2009. As rightly noted by Keay,[38] the Target Model of the EU IEM has been based on two main pillars: (1) energy-only market; and (2) market coupling. The Target Model of the EU electricity market is defined as:

> "[t]he blueprint with top-down guidance for regional market integration projects and is being implemented bottom-up through regional market coupling projects and top-down through the network codes that ACER [Agency for the Cooperation of Energy Regulator], EC and ENTSO-E [European Network of Transmission System Operators for Electricity] develop. The implementation of the target models in gas and electricity is equivalent to the completion of the IEM."[39]

As the meaning of energy-only markets was discussed in the previous chapter, here this issue is not dealt with in depth. Shortly, in this energy-only market model, generators are paid solely on their production and sales, and it is assumed that generators can get adequate profit to bear both capital and operational costs. Theoretically, the only way for this is that electricity prices should rise high enough in times of scarcity. However, market power abuse concerns and the highly political characteristic of electricity markets in Europe prevent prices rising adequately through price cap regulation, even in times of scarcity.[40] In contrast, market coupling as the second pillar of the Target Model can be defined as the integration of different European electricity markets through implicit capacity auctions in interconnections. The type

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[38] KEAY M., 'The EU "Target Model" for electricity markets: fit for purpose?', Oxford Energy Comment, The Oxford Institute for Energy Studies, May 2013, <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2013/05/The-EU-Target-Model-for-electricity-markets-fit-for-purpose.pdf> accessed 23.10.2016.

[39] ENTSO-E, 'Overview of Internal Electricity Market – related project work', 13.10.2014, <https://www.entsoe.eu/Documents/Events/2014/141013_ENTSO-E_Update-on-IEM-related%20project%20work_final.pdf>, accessed 23.10.2016, p.4.

[40] COIBON A. and PICKETT J., 'Capacity Mechanisms: Reigniting Europe`s Energy Markets', Linklaters LLP, 2014, <http://linklaters.de/fileadmin/redaktion/pdf/Linklaters%20Report_Capacity%20Markets.pdf> accessed 11.02.2016, p.6.

of electricity market coupling of the Target Model matters since capacity trading across borders, unlike the US cases, cannot be realised by renting interconnectors.[41]

Recently, experiences have shown that the Target Model based on energy-only markets and market coupling may not be adequate to ensure generation adequacy in many EU Member States. Therefore, almost half of Member States have established at least one type of CRM in their jurisdictions to deal with rising generation adequacy concerns. These concerns of Member States are either based on different causes or are felt at different levels while based on the same reasons. The challenges that have been faced Member States are examined individually below.

3.1 Rising Generation Adequacy Concerns in the EU Electricity Markets

The story of CRMs in the EU mainly started at the beginning of this decade.[42] Liberalisation and increasing integration in European electricity markets has revealed new challenges for generation adequacy.[43] Contrary to the popular belief, the rising concerns regarding generation adequacy in the EU are not primarily about shrinking reserve capacity (or, capacity margin) in electricity supply. Conversely, due to decreasing electricity demand as a result of the 2008 Global Financial Crisis, the Final Report of the Sector Inquiry on Capacity Mechanisms prepared by the Commission indicated that reserve capacities have widened in the EU, despite considerable differences among Member States.[44] However, the level of reserve margin itself does not show that generation adequacy can be ensured without any challenges. At this point, the missing money problem, as in other parts of the world, appears as the main cause of the increasing generation adequacy concerns in the EU. Additionally, a

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[41] This issue is further handled in Chapter 4.

[42] Of course, this does not mean that there were not any discussions regarding CRMs in any Member States. For instance, capacity payments as a type of CRMs has been implemented in different the EU countries such as the UK, Spain, Portugal, Italy and Ireland in different time periods in last decades.

[43] European Commission, 'Staff Working Document: Generation adequacy in the internal electricity market – guidance on public interventions', SWD (2013) 438 final, Brussels, 05.11.2013, <https://ec.europa.eu/energy/sites/ener/files/documents/swd_2016_385_f1_other_staff_working_paper_en_v3_p1_870001.pdf> accessed 26.02.2018, p.2.

[44] For instance, in 2013, the margin was highest in Denmark, Spain, Italy and Portugal while it was smallest in Belgium, Croatia, Poland and Sweden. *See* European Commission, 'Commission Staff Working Document, Final Report of the Sector Inquiry on Capacity Mechanisms', SWD(2016) 385 final, Brussels, 30.11.2016, <http://ec.europa.eu/competition/sectors/energy/capacity_mechanism_swd_en.pdf> accessed 25.02.2018, p.16.

range of interrelated policy developments including the rising share of intermittent RESs in Member States' generation mixes, low carbon prices, decreasing growth of electricity demand due to the world-wide economic crisis, the competitive advantage of coal against natural gas and low wholesale electricity prices[45] have exacerbated the missing money problem.[46] Some authors define the combined effect of these policy developments as a "perfect storm".[47]

In consequence of the combined effect of the abovementioned policy developments, the profitability of conventional power plants has substantially decreased in recent years.[48] To give some concrete examples, it should be noted that between 2008 and 2013, the average utilisation of conventional power plants decreased from 50% to 37% due to massive increases in renewable energy investments as well as the world-wide economic crisis.[49] Caldecott and McDaniels show that base-load plants, including especially gas power plants, built with the expectations of high running hours had continuously low or even negative spark spreads because of their declining running hours in line with the increasing share of renewable energy

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[45] IEA estimates that in 2013 electricity prices in the European wholesale markets was about 23% below than needed to recover supply costs. *See* IEA, 'Special Report on World Energy Investment Outlook 2014', OECD/IEA, Paris, 2014, <https://www.iea.org/publications/freepublications/publication/WEIO2014.pdf> accessed 03.03.2018, p.113.

[46] It can be discussed that among these policy developments that flamed the missing money problem, increasing share of intermittent RES such as solar and wind power in Member States' energy mixes seems the most serious challenge that should be overcome. Other challenges mentioned above can be seen as cyclical or can be solved through some relatively easier regulatory changes; however, intermittent RESs cause mainly structural problems.

[47] *See* ROQUES F., 'European Electricity Markets in Crisis: Diagnostic and Way Forward', in 'The Crisis of the European Electricity System Diagnosis and possible ways forward', Strategie, January 2014, <http://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/archives/CGSP_Report_European_Electricity_System_030220141.pdf> accessed 11.02.2016, p.79, pp.77-117 and COIBION A. and PICKETT J., 'Capacity Mechanisms: Reigniting Europe`s Energy Markets', *Supra* note 40, p. 2.

[48] It is known that the importance of these conventional plants, especially gas-power plants, is gradually increasing due to the fact that these power plants provide flexibility which is a vital product in such electricity markets that dominate by intermittent electricity sources rather than conventional power plants. For the relationship between the intermittency and the need for flexibility, *See*, CAILLIAU M. et al, 'Integrating Intermittent Renewable Sources into the EU Electricity System by 2020', Eurelectric Report, 2010, <http://www.eurelectric.org/media/45254/res_integration_paper_final-2010-030-0492-01-e.pdf> accessed 11.02.2016.

[49] COIBON A. and PICKETT J., 'Capacity Mechanisms: Reigniting Europe`s Energy Markets', 'Capacity Mechanisms: Reigniting Europe`s Energy Markets', *Supra* note 40, p.3

sources.[50] According to the Special Report on World Energy Investment Outlook 2014 prepared by the IEA, the 20 largest publicly listed EU utilities lost about 85% of their combined net income between 2009 and 2013.[51] As a result of decreasing operating hours, competitive coal prices, low carbon and wholesale electricity prices, even high-efficiency gas power plants have not been able to reimburse their capital costs since 2011.[52] Hence, many generators in Europe have decided to mothball or permanently retire earlier than their capital costs are recovered. For instance, it is said that 24 GW of thermal power plant in the EU have been mothballed and 7 GW decommissioned in 2013.[53] In the same direction, Caldecott and McDaniels argued that ten utilities in the EU declared the mothballing or closure of 20.08 GW of gas-power plants in 2012-2013.[54] Furthermore, it was estimated that 110 GW of generation capacity, nearly a third of total thermal generation capacity of Europe, are at risk of being decommissioned or mothballed in coming years.[55]

On this issue, many researchers have noted that the current electricity market structure is not sufficient to maintain a certain level of security of supply.[56] In their highly informative

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[50] CALDECOTT B. and MCDANIELS J., 'Stranded generation assets: Implications for European capacity mechanisms, energy markets and climate policy', Working Paper, Smith School of Enterprise and the Environment, University of Oxford, January 2014, <http://www.smithschool.ox.ac.uk/research/sustainable-finance/publications/Stranded-Generation-Assets.pdf> accessed 11.02.2016, p.5.

[51] IEA, 'Special Report on World Energy Investment Outlook 2014', *Supra* note 45, p.113.

[52] *ibid*.

[53]COIBON A. and PICKETT J., Capacity Mechanisms: Reigniting Europe`s Energy Markets', *Supra* note 40, p.2.

[54] CALDECOTT B. and MCDANIELS J., 'Stranded generation assets: Implications for European capacity mechanisms, energy markets and climate policy', *Supra* note 50, p.12.

[55] IHS CERA, 'Keeping Europe's Lights On: Design and Impact of Capacity Mechanisms', <http://www.ihs.com/products/cera/multi-client-studies/europe-capacity-mechanisms.aspx> accessed 28.09.2014.

[56] For instance, *See*, NEWBERY D., 'Evolution of the British Electricity Market and the Role of Policy for the Low-Carbon Future' in SIOSHANSI F. (ed), *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, 2013, p.10, pp.3-29; KEAY M., RHYS J. and ROBINSON D., 'Electricity Market Reform in Britain: Central Planning versus Free Markets', in SIOSHANSI F. (ed), *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, 2013, p. 55, pp.31-57;. HAAS R. et al, 'The Growing Impact of Renewable Energy in European Electricity Markets', in SIOSHANSI F. (ed), *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, 2013, p.143, pp.125-146; BAUKNECHT D. et al, 'From Niche to Mainstream: The Evolution of Renewable Energy in the German Electricity Market' in SIOSHANSI F. (ed), *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, 2013, p.185,pp.169-198 and

article, although Glachant and Ruester emphasised the achievements of the liberalisation movement in EU Electricity Markets in recent decades, they also argued that unexpected developments in the EU Electricity Markets such as an increasing share of intermittent RESs, decreasing working hours of conventional power plants while increasing needs for flexibility and decentralisation of electricity generation have created tough challenges that the current electricity market design of the EU cannot overcome.[57] Similarly, Keay et al. argues that:

> "[…] existing markets will not generate the level of and types of investment which many governments are aiming at. It is difficult for those governments to find market-friendly measures to guide investment; low-carbon generation tends to be unattractive to investors because of its inflexibility, high levelized costs, and capital intensity."[58]

Not only academic papers but also reports prepared by national and supranational institutions have highlighted the inadequacy of current electricity markets against emerging challenges. Office of Gas and Electricity Markets (Ofgem), for example, notes that "[t]he unprecedented combination of the global financial crisis, tough environmental targets, increasing gas import dependency and the closure of ageing power stations has combined to cast reasonable doubt over whether the current energy arrangements will deliver secure and sustainable energy supplies."[59] Similarly, ACER noted that energy-only markets could deliver generation adequacy if electricity prices in the market were allowed to move freely in compliance with the law of supply and demand, that demand was able to respond short-term price signals and, at scarcity times, prices could rise up to the level of VOLL as well as a stable

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GLACHANT J. M., and RUESTER S., 'The EU internal electricity market: Done forever?', (2014), 30 *Utilities Policy*, p.1, pp.1-7.

[57] GLACHANT J.M. and RUESTER S., 'The EU internal electricity market: Done forever?', *Supra* note 56, pp.1-7.

[58] KEAY M., RHYS J. and ROBINSON D., 'Electricity Market Reform in Britain: Central Planning versus Free Markets', *Supra* note 56, p. 55.

[59] Ofgem, 'Action Needed To Ensure Britain's Energy Supplies Remain Secure' Press Release, 03.02.2010, <https://www.ofgem.gov.uk/ofgem-publications/76371/ofgem-discovery-phase-ii-draft-v15.pdf> accessed 25.02.2018.

policy and regulatory regime would give confidence to investors.[60] Actually, ACER here repeats what the theory says. However, after saying this, ACER stated that it is aware that, under the current situation, these conditions may not always be met because of the two reasons set forth below:[61]

- There is a considerable intervention in power pricing by putting price caps implicitly or explicitly, as continued high prices and frequent price spikes may be politically unacceptable.
- There is a limited demand-side participation although different regulatory frameworks and technics can be put in place to foster it.

Therefore, ACER indicates that "in practice, as long as the conditions outlined above are not met, there is no guarantee, even once the EU electricity market integration process is completed, that energy-only market will be able by itself to deliver the required level of resource adequacy and system flexibility."[62]

In a nutshell, even if there are no compound effects from rising intermittent RESs alongside the shale gas revolution and carbon market failure, it can be guessed that an energy-only market structure may no longer be sufficient for European needs.[63]

The next section will individually analyse the challenges that have led to the birth of CRMs in many European countries in recent years. These challenges are examined under two sub-headings. First, challenges which are compatible with what the Conceptual Framework has suggested in Chapter 2. These challenges are the classical missing money problem, which is a result of price cap regulations or direct/indirect price suppression practices, and the rising share of intermittent RESs in European electricity markets, which creates a new type of missing money problem as an exacerbating effect of the classical missing money problem. The second sub-heading includes challenges that can be defined as the European-specific reasons for the increasing generation adequacy concerns. These reasons (including low carbon prices, phasing out coal and nuclear power plants, flood of cheap shale gas and the

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[60] ACER, 'Opinion No.05/2013 of 15 February 2013 on Capacity Mechanisms', <http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Opinions/Opinions/ACER%20Opinion%2005-2013.pdf> accessed 25.02.2018, p.8-9.

[61] *ibid*, p.9

[62] *ibid.*

[63] *ibid.*

Global Financial Crisis 2008) also exacerbate the missing money problem as such in the rising share of intermittent RESs. However, it may be claimed that while rising intermittency is a structural challenge, these reasons cause temporary or cyclical problems.

3.1.1 Challenges Compatible with the Conceptual Framework

3.1.1.1 The Missing Money Problem

As in other regions around the world such as Latin America and the US, the missing money problem lies behind challenges regarding increasing generation adequacy concerns. The missing money problem, as discussed in the previous chapter, can be defined as the lack of sufficient incentive to keep existing generators online and/or attract new investments.[64] This naturally endangers generation adequacy in the long run. On this matter, many scholars, for instance Hogan,[65] Cramton and Stoft,[66] and Joskow[67] argued that the main reasons behind the missing money problem are several regulatory and market failures such as price cap regulation, and that electricity prices cannot increase enough to cover investment costs. This is not only a theoretical problem in European electricity markets. For instance, in its decision regarding the UK Capacity Market, the Commission stated that:

> "Historically, GB cash-out prices [imbalance prices] have not exceeded GBP 938/MWh. The UK submits that the evidence from recent scarcity situations in the GB market also indicates that prices have not risen to the levels that would have been expected. The Government and Ofgem commissioned an independent study to estimate the value of lost load, which has concluded that the average value to

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[64] HOGAN W.W., 'On an "Energy Only" Electricity Market Design for Resource Adequacy', 23.09.2005, <http://www.hks.harvard.edu/fs/whogan/Hogan_Energy_Only_092305.pdf> accessed 04.11.2013, p.1.
[65] *ibid*.
[66] CRAMTON P. and STOFT S., 'The Convergence of Market Designs for Adequate Generating Capacity with Special Attention to the CAISO`s Resource Adequacy Problem: A White Paper for the Electricity Oversight Board', 25.04.2006, <http://www.cramton.umd.edu/papers2005-2009/cramton-stoft-market-design-for-resource-adequacy.pdf> accessed 11.02.2016, p. 11.
[67] JOSKOW P.L., 'Competitive Electricity Markets and Investment in New Generating Capacity', 12.06.2006, <http://economics.mit.edu/files/1190> accessed 11.02.2016, p.31.

consumers of preventing disconnections at times of system peak is around GBP 17,000/MWh."[68]

Table 7 below shows price caps for day-ahead, intraday and balancing markets for 11 Member States of the EU. It also illustrates the estimations of VOLL for the same 11 Member States. Firstly, it should be noticed that price caps in the 11 Member States are not even close to estimations of VOLL. This situation is the classical reason of the missing money problem. However, Table 8 below shows that most of the time, wholesale electricity prices between 2011 and 2015 in 11 Member States did not even rise close to price caps which are designed much less than VOLL.

Table 7 Wholesale Price Caps and Estimates of VOLL (EUR/MWh)[69]

Wholesale Price Caps and estimates of VOLL (EUR/MWh)				
Country	Day-ahead	Intraday	Balancing	Estimate of VOLL[29]
Belgium	3,000	9,999	4,500	n.a.
Denmark	3,000	No cap	5,000	Between 2,933 and 36,800
Croatia	3,000	No exchange trading. No OTC cap.	No cap	n.a.
France	3,000	9,999	9,999	26,000
Germany	3,000	9,999	No cap	n.a.
Ireland	1,000 (moving to 3,000 in future)	1,000 (moving to 3,000 in future)	No balancing market. Price cap TBC for future market design	11,017.98
Italy	3,000	3,000	3,000	3,000
Poland	~350	No cap	~350	Between ~1,250 and ~2,100
Portugal	180	180	No cap	3,000
Spain	180	180	No cap	n.a.
Sweden	3,000	No cap	5,000	Between ~2,800 and ~7,600

Table 8 Highest prices experienced in 11 Member States (EUR/MWh)[70]

[68] European Commission, 'State aid SA.35980 (2014/N-2) – United Kingdom Electricity market reform – Capacity market', Brussels, 23.7.2014 C (2014) 5083 final, <http://ec.europa.eu/competition/state_aid/cases/253240/253240_1579271_165_2.pdf> accessed 04.03.2018, para. 86.
[69] European Commission, 'Commission Staff Working Document, Final Report of the Sector Inquiry on Capacity Mechanisms', *Supra* note 44, p.30.
[70] *Ibid*, p. 34.

Highest prices experienced in the 11 Member States (EUR/MWh)				
Country	Year	Day-ahead	Intraday	Balancing
Belgium	2015			801.3
	2014			848.5
	2013			1488.2
	2012			1408.9
	2011			
Denmark DK1	2015	~13	~16	~36
	2014	~21	~17	~35
	2013	~268	~40	~268
	2012	~28	~54	~67
	2011	~15	~22	~90
Denmark DK2	2015	~20	~22	~268
	2014	~14	~20	~36
	2013	~17	~20	~36
	2012	~34	~54	~124
	2011	~26	~38	~135
France	2015	123	749	266
	2014	97	200	594
	2013	180	432	283
	2012	1939	1785	1939
	2011	117	250	287
Germany	2015	99.77	121.66	
	2014	87.97	139.12	5998.41
	2013	130.27	163.44	1608.20
	2012	210	272.95	1501.20
	2011	117.49	162.06	551.60
Ireland	2015	367.33	461.14	472.93
	2014	617.92	488.36	955.38
	2013	484.52	572.75	1000
	2012	563.06	587.12	675.58
	2011	587.58		959.36
Italy	2015	146	3000	1670
	2014	276	3000	1000
	2013	399	3000	3000
	2012	3000	3000	2999
	2011	300	3000	1500
Poland	2015	~333	~271	~316
	2014	~318	~291	~343
	2013	~90	~113	~145
	2012	~217	~152	~360
	2011	~151	~120	~332
Portugal	2015	85.05	180.3	180.3
	2014	110	93.9	190
	2013	112	180.3	255
	2012	90.13	180.3	350
	2011	100	170	225
Spain	2015	66.71	90	180.3
	2014	85.05	88	139.98
	2013	113.92	95.92	200
	2012	112	130	658
	2011	90.13	115	180.32
Sweden	2015	105.06	200	579.69
	2014	105.39	400	831.31
	2013	111.57	300	734.80
	2012	253.97	555	549.22
	2011	111.10	500	1342.53

Note: No data was provided for Croatia. Red underlined figures indicate the price cap was met.

As a critical matter, the difference between explicit and implicit price caps mentioned in Chapter 2 analysed under the subheading of 3.2.2 The Missing Money Problem should be remembered. This is because this difference is important in-order to comprehend the source of the missing money problem in EU electricity markets. In European electricity markets the implicit price cap, rather than the explicit price cap, appears more relevant for the missing money problem. Prices in European electricity markets do not usually have tested price caps (*See* Table 8 above). Nevertheless, this may happen due to some out of market mechanisms such as the prohibition of power plants in Germany for the sake of reliability.[71] Legally prohibiting the closure of electricity generation facilities with implicit price cap regulation causes discouragement for new capacity investment and may lead to the necessity for establishing CRMs.[72]

Not only prohibiting the closure of power plants but also other kinds of out of market regulation which detrimentally affect price mechanisms in electricity markets may increase the requirement for CRMs. For instance, the Commission, on this matter, noted that:

> "Even in the absence of explicit price caps, the rules for managing balancing markets, […], in practice cap the price in forward markets. For instance, penalties for imbalance at the moment of delivery can act as an implicit price cap in day - ahead and other forward markets if they are too low, because operators may prefer paying the penalty than paying high prices."[73]

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[71] LANG M. and LANG A., 'IW/Handelsblatt: Energy Transition Costs EUR 28 Billion per Year – Shutdown of 57 Power Plants', German Energy Blog, 25.08.2015, <http://www.germanenergyblog.de/?p=19319>, accessed 25.02.2018.

[72] BÖCKERS V. F. P., 'Market Integration and Regulation in European Wholesale Electricity Markets: Five Essays on Energy Economics', PhD Thesis, <https://docserv.uni-duesseldorf.de/servlets/DerivateServlet/Derivate-35440/Böckers%2C%20Market%20Integration%20and%20Regulation%20in%20the%20European%20Wholesale%20Electricity%20Markets%20-%20Five%20Essays%20on%20Energy%20Economics.pdf>, accessed 25.02.2018, p. 152.

[73] European Commission, 'Report From The Commission, Final Report of the Sector Inquiry on Capacity Mechanisms', COM(2016) 752 final, Brussels, 30.11.2016, <http://ec.europa.eu/competition/sectors/energy/capacity_mechanisms_final_report_en.pdf>, accessed 25.02.2018, p.5

Understandably, these out of market mechanisms suppress electricity prices and, therefore, disincentive introducing any new generation investment. So, it can be said that out of market mechanisms create implicit price caps in European countries.

3.1.1.1.1 Rising Renewable Energy Sources in Generation Mixes: The Exacerbating Effect or New Type of Missing Money Problem in EU Electricity Markets

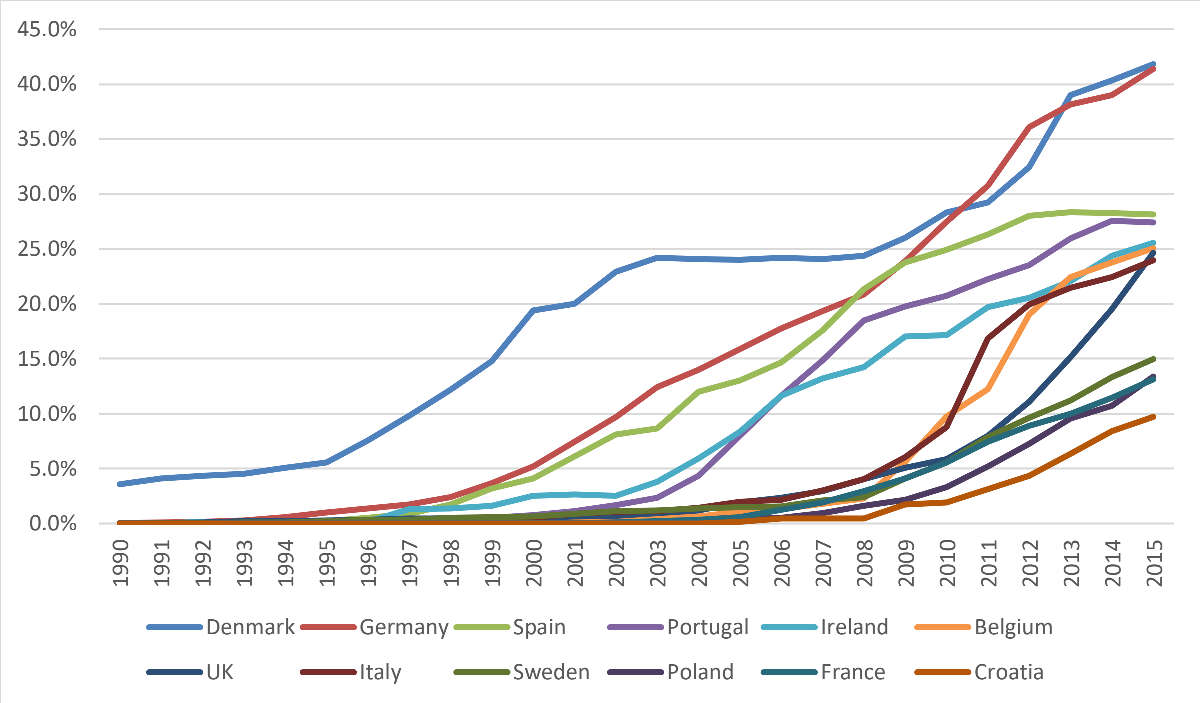
The EU regulatory framework for electricity markets has always given special attention to RESs to decarbonise electricity markets. It binds Member States to develop support schemes to increase the share of RESs in general electricity consumption.[74] In line with this binding rule, Member States have developed a range of support schemes for RESs.[75] In company with increasing utilization of RESs in electricity generation, the policy of supporting intermittent generation has achieved outstanding success in Europe.[76] Figure 13 below illustrates how this success has evolved in 12 Member States between 1990 and 2015.

[74] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance), OJ L 140, 5.6.2009, pp.16-62, Article 3 (Renewable Energy Directive).

[75] Renewable energy support schemes are out of scope of this thesis. Therefore, they are not analysed here. For further information about these schemes *See* RAGWITZ M. et al, 'D23 Final Report: RE-Shaping: Shaping an effective and efficient European renewable energy market', February 2012, <http://www.reshaping-res-policy.eu/downloads/Final%20report%20RE-Shaping_Druck_D23.pdf> accessed 28.07.2015.

[76] *Ibid.*

Figure 13 Intermittent Capacity Increases in 12 Member States of the EU between 1990 and 2015 (as a %)[77]



Another estimation suggests that the percentage of RESs in electricity generation within the EU will rise from 21% in 2010 to 34-36% by 2020.[78] For instance, in Germany, the share of RESs in generation is expected to reach 42% by 2020, of which the largest proportion of this increase belongs to offshore and onshore wind.[79] Of course, these successes have an alternative cost for the European electricity markets, particularly in terms of generation adequacy. In Chapter 2, it was discussed that the rising share of intermittent RESs in generation mixes has created a new kind of challenge called *flexibility* for ensuring generation adequacy. *Flexibility* stands out as a growing problem for the European electricity markets in recent years. It is obvious that the emergence of flexibility as a new challenge in EU electricity markets is directly related to the rising share of intermittent RESs. Compared to other parts of the world, this is more radically felt in Europe. The reason why *flexibility* has more deeply affected Europe can be explained by the fact that EU electricity markets are like a laboratory

[77] Prepared by the Author based on the Data provided by the Commission, *See*, European Commission, Energy Data & Analysis By Country, <https://ec.europa.eu/energy/en/data-analysis/country> accessed 10.09.2017.
[78] HAAS R. et al, 'The Growing Impact of Renewable Energy in European Electricity Markets', *Supra* note 56, p. 125.
[79] BAUKNECHT D. et al, 'From Niche to Mainstream: The Evolution of Renewable Energy in the German Electricity Market', *Supra* note 56, p.171.

for other electricity markets in the world in this period of transition.[80] When the share of intermittent RESs was marginal in general electricity consumption, the focus was on how to promote RESs in an effective and efficient way.[81] However, this focus has shifted from that point to the question of how rising intermittency in electricity markets affect the whole electricity system.[82] Given the rising share of RESs in general electricity consumption, the risks faced by conventional power plants are now very different faced by them in the past. Meyer et al showed two outcomes of the rising share of RESs:[83] First, the increasing share of RESs makes a merit order effect[84] which pushes conventional power plants, especially gas-power plants, out of merit order; and, second, constraints on the operating hours of existing conventional power plants means that they run far less frequently than before.[85] By all given projections, the revenue stream of conventional power plants will be more volatile and uncertain, and investment in these plants will therefore be riskier. However, because of the product *flexibility* they provide, the need for them will continue. Gonzalez-Diaz argued that the rising share of RESs in generation mixes pushes conventional power plants out of merit-order; however, since RESs cannot provide reliable electricity, conventional power plants

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[80] *See* 'Introduction' part of this Chapter.

[81] BAUKNECHT D. et al, 'From Niche to Mainstream: The Evolution of Renewable Energy in the German Electricity Market', *Supra* note 56, p.171.

[82] *Ibid*.

[83] MEYER R. et al, 'Analysis of Capacity Remunerative Mechanisms (CRMS) In Europe from The Internal Electricity Market Point of View', Elforsk rapport, March 2014, p. 2-3.

[84] In literature, the effect of RESs on the operating hours of the thermal power plants is known as the merit-order effect, which means that as the share of RESs increases in energy mix, it pushes conventional power plants in the right direction on merit order. Actually, this effect has been known for a long period of time. *See* SENSFUß F. et al., 'The merit-order effect: A detailed analysis of the price effect of renewable electricity generation on spot market prices in Germany' *Energy Policy* Volume 36, Issue 8, August 2008, pp.3086-3094; NICOLOSI M. and FÜRSCH M., 'The Impact of an increasing share of RES-E on the Conventional Power Market – The Example of Germany', (2009), *ZfE Zeitschrift für Energiewirtschaft* 03, pp.246-254 <http://www.ewi.uni-koeln.de/fileadmin/user_upload/Publikationen/Zeitschriften/2009/09_03_01_Nicolosi_Fuersch_Zfe.pdf>, accessed 25.02.2018.

[85] The reason for declining hours of conventional power plants is the priority of RESs pursuant to Article 16(2) of the Renewable Energy Directive. *See* Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, *Supra* note 74.

must be in the system as back-up and flexible capacity source to ensure generation adequacy.[86]

On this issue, Vanderberghe and Gonne claimed that because of generously supported intermittent RESs and its damaging effect for particularly large scale and flexible gas power plants, a new type of missing money problem has occurred.[87] The rise of RESs share in electricity generation seems as a powerful rationale, perhaps more powerful than price cap regulation, behind the European CRMs. Actually, CRMs in Europe seem to fit perfectly with the changing role of conventional power plants in such an electricity market structure dominated by intermittent RESs. This argument is put into words by Baucknecht et al by saying that in an electricity market led by RESs, the role of conventional power plants shifts from the base load supply to become capacity reserve so as to take action where RESs cannot supply adequate electricity. [88]

3.1.1.2 Other Challenges

In addition to the classical missing money problem and rising intermittency, there are other challenges causing generation adequacy concerns in the EU. They can be ranged as the public good characteristic of reliability and the lack of sufficient long-term contracts. Because the issue of long-term contracts is handled in Chapter 2 (under the subheading of 3.2.3.2 Forward Markets in Energy-only Markets: Why are not they adequately employed for attracting generation investments?) within the context of European countries, it is not mentioned here anymore. However, it has been accepted by both Member States and the Commission that reliability of electricity supply has the characteristic of public goods which creates market failures in electricity markets. The Commission has argued several times in different documents that reliability of electricity supply has many characters of a public good since consumers presently cannot decide their reliability level because of their passive situation in

[86] GONZALEZ-DIAZ F. E., `EU Policy on Capacity Mechanisms` in HANCHER L. et al (eds), *Capacity Mechanisms in the EU Energy Market: Law, Policy and Economics,* Oxford University Press, UK, 2015, pp.5-7.
[87] VANDERBERGHE W. and GONNE R., ‘Belgium’, in HANCHER L. et al (eds), *Capacity Mechanisms in the EU Energy Market: Law, Policy and Economics,* Oxford University Press, UK, 2015, p.244.
[88] BAUKNECHT D. et al, ‘From Niche to Mainstream: The Evolution of Renewable Energy in the German Electricity Market’, *Supra* note 56, p.191.

reacting to the price changes in real time.[89] Furthermore, SOs cannot selectively cease electricity supply for certain consumers due to the same reason, i.e. inability of demand-side to price changes in real time.[90] The Commission, in other respects, mentioned the importance of technological development to overcome the challenges caused by the public good characteristic of reliability.[91] On this point, the Commission indicated that with proliferation of smart technology, public good characteristic of reliability of electricity supply will become less significant since consumers in future will able to adjust their electricity demand in terms of scarcity situations in the market.[92]

Following the above discussion, some Member States including the UK and France accept reliability of electricity supply as a public good. When these countries set up their own CRMs, they highlighted the public good characteristics of reliability as an important reason. For instance, France clearly explains why its energy-only market cannot produce sufficient capacity investment for ensuring reliability from the perspective of public goods theory:

> "Security of supply is […] a public good: when it is guaranteed, everyone benefits, but when this is not the case all network users are affected, regardless of the value they place on it. The availability of peak capacities creates positive externalities for security of supply with no financial benefits for operators of these capacities. This reduces

[89] European Commission, Decision State aid SA.35980 (2014/N-2), United Kingdom Electricity market reform – Capacity Market, *Supra* note 68, p.34; European Commission, 'Assessing Generation Adequacy and the Necessity of Capacity Mechanisms' Capacity Mechanisms Working Group, 22 January 2015, <http://ec.europa.eu/competition/sectors/energy/capacity_mechanisms_working_group_1.pdf>, accessed 25.02.2018, p.2; European Commission, 'Commission Staff Working Document, Final Report of the Sector Inquiry on Capacity Mechanisms', *Supra* note 44, pp.38.39.
[90] European Commission, 'Assessing Generation Adequacy and the Necessity of Capacity Mechanisms', *Supra* note 89, p.2.
[91] European Commission, Decision State aid SA.35980 (2014/N-2), United Kingdom Electricity market reform – Capacity Market, *Supra* note 68, p.34.
[92] *ibid*.

> investment incentives: it is not in the interest of market stakeholders."[93]

Likewise, the UK authorities also regard the reliability of electricity supply as a public good, and accordingly they believe that the market mechanism is not able to provide energy security on its own. For instance, in the Impact Assessment on Capacity Market prepared in 2014, Department and Energy & Climate Change (DECC) argued that the primary market failure of energy-only market is that reliability is a quasi-public good; that is, consumers cannot decide their preferred level of reliability since SO cannot selectively blackout electricity for customers (non-excludability).[94] Therefore, according to DECC, the market itself cannot provide adequate level of reliability without government intervention.[95]

The opinions of the Commission, France and the UK mentioned above have shown that one of the most important reasons for the establishment of CRMs in Member States is that reliability of electricity supply is regarded as a public good. This evaluation is in line with the Conceptual Framework revealed in Chapter 2.

3.1.2 The European-centric reasons for increasing generation adequacy concerns: Reasons exacerbating the missing money problem

3.1.2.1 Low carbon prices – Failure of ETS Scheme

The EU ETS was launched in 2005 by Directive 2003/87/EC,[96] and was developed to deal with climate change and became one of the main pillars of the EU energy policy since it was started. The EU ETS programme covers energy and energy-intensive sectors including steel,

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[93] RTE (The French TSO), 'French Capacity Market: Report accompanying the draft rules', 09.04.2014, <http://www.rte-france.com/sites/default/files/2014_04_09_french_capacity_market.pdf> accessed 26.02.2018, p.22.

[94] DECC, 'Electricity Market Reform – Capacity Market', 23.06.2014, <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/324430/Final_Capacity_Market_Impact_Assessment.pdf>, accessed 26.02.2018, p.12.

[95] *İbid*.

[96] Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (Text with EEA relevance),, OJ L 275, 25.10.2003, pp.32-46.

aluminium, paper and chemicals.[97] It is implemented in 31 countries including 28 Member States as well as Iceland, Liechtenstein and Norway.[98] Further, it covers 45% of the total greenhouse gas emissions of the EU.[99] The ETS works with the "cap and trade principle", meaning that there is a "cap" which reveals the total amount of greenhouses gases that can be emitted over a certain period of time by companies. This "cap" is set to decrease in time and within this term, companies can receive or buy "emission allowances" prepared in accordance with the "cap".[100] As indicated by the Commission, a well-designed ETS Scheme should support new investment in clean and low-carbon technologies in electricity markets.[101] Nevertheless, it has not produced a sufficiently high carbon price that could incentivise low-carbon technologies and, hence, reduce carbon emissions.[102] Carbon prices in the EU severely decreased from 22.3 €/tCO2 in 2008 to 7.0 €/tCO2 in 2015. Naturally, this adversely affected the competitiveness of gas-power plants against coal-power stations.[103] In the same vein, according to the IEA, carbon prices have weakened between the range of €4-7 per tonne of CO2 in recent years.[104] Figure 14 below also shows how carbon prices have hit the bottom in recent years. Recently, the EU has initiated reform to overcome the deficiencies and, therefore, to increase the carbon price to provide sufficient incentive for low-carbon technologies. By altering the supply of allowances, the purpose is to increase carbon prices adequately to support large-scale fuel converting into low-carbon electricity sources.[105] However, according to a report, "[t]he proposed reforms of the EU ETS […] cannot be expected to change this picture. Prices for emission allowances through 2030 are projected

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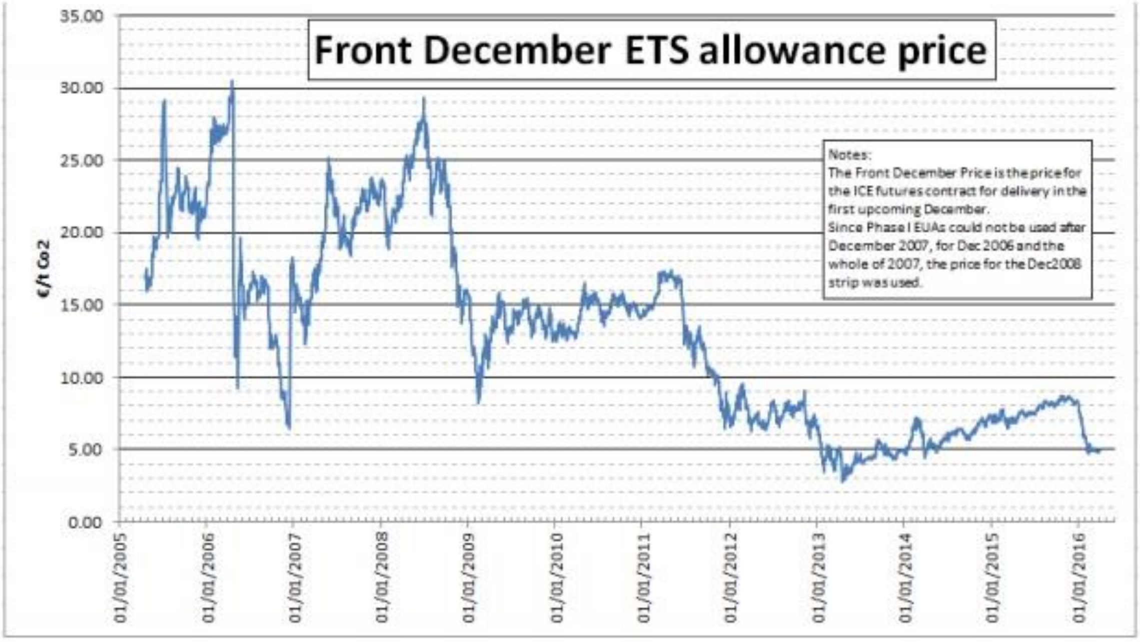
[97] GÜNTER B., 'In the Market: Reforming the EU ETS Revisited', *Carbon & Climate Law Review (CCLR),* Vol. 2014, Issue 1 (2014), pp. 65-68.
[98] European Commission, 'The EU Emissions Trading System (EU ETS)', <https://ec.europa.eu/clima/policies/ets_en> accessed 26.02.2018.
[99] *ibid*.
[100] *ibid*.
[101] *ibid*.
[102] BURG L. van der and WHITLEY S., 'Rethinking power markets: capacity mechanisms and decarbonisation', Overseas Development Institute, May 2016, <https://www.odi.org/sites/odi.org.uk/files/resource-documents/10569.pdf> accessed 26.02.2018, p.12.
[103] European Commission, `Energy Economic Developments: Investment Perspectives in Electricity Markets`, Institutional Paper 003, July 2015, <https://ec.europa.eu/info/sites/info/files/file_import/ip003_en_2.pdf> accessed 26.02.2018, p.14.
[104] IEA, 'World Energy Outlook 2016', *Supra* note 6, p.270.
[105] *Ibid*.

to remain well below what is likely to be needed to shift investment and production towards cleaner, more flexible resources such as gas-fired power plants."[106]

Figure 14: Evolution of EU ETS carbon price[107]



3.1.2.2 Phasing out nuclear and coal power plants

A range of Member States are preparing to phase out their nuclear and coal power plants either because of environmental concerns or due to the fact that a significant proportion of current generation capacity is approaching their end of operational life-time.[108] The IEA indicates that, as far as the New Policies Scenario is concerned, about $15 billion per year ("including plants already under construction") is required for the European electricity markets so as to extend the lifetime or replace the large share of existing conventional power plants.[109] While some Member States such as France are investing to extend the life of current nuclear power plants, other Member States are preparing to close substantial amount of

[106] BUCK M. et al, 'The Market Design Initiative and Path Dependency: Smart retirement of old, high-carbon, inflexible capacity as a prerequisite for a successful market design', November 2015 <https://www.agora-energiewende.de/fileadmin/Projekte/2015/Smart-Retirement/Agora_RAP_Smart-Retirement-and-MDI-Background.pdf>, accessed 26.02.2018, pp. 2-3.
[107] European Commission, 'Commission Staff Working Document, Final Report of the Sector Inquiry on Capacity Mechanisms', *Supra* note 44, p.22.
[108] European Commission, 'Commission Staff Working Document, Final Report of the Sector Inquiry on Capacity Mechanisms', *Supra* note 44, p. 23.
[109] IEA, 'World Energy Outlook 2016', *Supra* note 6, p. 272.

nuclear power plant in the coming decades.[110] With regard to coal-power plants, they are strong candidates to be closed due to not only their age but also their detrimental effects to environment.[111] In other words, even market mechanisms will not end the life of nuclear and coal power plants. Instead, it can be seen that environmental regulations which are gaining more importance day by day in the EU will close these power plants in the coming decades. In this sense two Member States come to the forefront: Belgium and Germany. Vanderberghe and Gonne noted that in Belgium, a significant portion of existing conventional power plant is being shut down and/or mothballed due to the fact that more than half of the conventional power plants are older than thirty and even 40 years.[112] Thus, as indicated by Vanderberghe and Gonne,[113] most of these power plants no longer comply with European environmental regulations.

The Nuclear Phase Out Act entered into force in 2003 postponed the building of new nuclear power plants in Belgium.[114] It has limited the lifetime of existing nuclear power plants to 40 years, with the exception of a government decree enacting in order to extend these lifetimes owing to generation adequacy concerns.[115] According to this Law, Belgium must close all of its nuclear power plants by 2025.[116] However, when looking at Belgium's generation mix, it is easy to understand that it is extremely hard for the Belgian government to satisfy this policy objective. As of 19 November 2016, in terms of overall installed capacity, the share of nuclear power plants constituted 40.84%.[117] As indicated by the IEA in its 2016 Review of Belgium Energy Policy, the existing energy policy of Belgium aiming to close all nuclear power plants

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[110] *İbid*.
[111] *İbid*.
[112] VANDERBERGHE W. and GONNE R., 'Belgium', *Supra* note 87, p.244.
[113] *ibid*.
[114] *Ibid*. p.241.
[115] *ibid*. In line with this, the Belgian government extended the operation term of two nuclear power plants named Doel and Tihange until 2025 in December 2015, although they were scheduled to close in 2015. *See* The Guardian, 'Belgium rejects German call for nuclear plants closure', 20.04.2016, <https://www.theguardian.com/environment/2016/apr/20/belgium-rejects-german-call-for-nuclear-plants-closure> accessed 20.11.2016.
[116] IEA, 'Energy Policies of IEA Countries: Belgium 2016 Review', OECD/IEA, Paris, 2016, <https://www.iea.org/publications/freepublications/publication/Energy_Policies_of_IEA_Countries_Belgium_2016_Review.pdf>, accessed 26.02.2018, p.10.
[117] Elia (The Belgium TSO), 'Generating facilities', <http://www.elia.be/en/grid-data/power-generation/generating-facilities> accessed 20.11.2016.

endangers generation adequacy, especially for the first half of next decade.[118] Therefore, the IEA is inviting Belgium to revise its nuclear power policy.[119]

As in Belgium, Germany plans to phase its nuclear power plants. In fact, the German Decision regarding phasing out nuclear power plant is not new. In 2000, the coalition government comprised of the Socialist Party and the Green Party (or, The German Red-Green Government) decided to shut down nuclear plants by 2022.[120] This decision was changed in November 2010 by the Bundestag (German Parliament) and 17 nuclear power plants had their lifetimes extended by an average of 12 years.[121] Nevertheless, after the catastrophic effect of the Fukushima-Daiichi accident happened in Japan in 2011, Germany reconsidered its nuclear policy and closed the 7 oldest and the Krummel nuclear power plant (having an installed capacity of 8.8 GW in total) in March 2011.[122] Furthermore, it was decided that the residual 9 nuclear power plants (having an installed capacity of 12.7 GW in total) will be closed by the end of 2022.[123] This unilateral and radical decision of Germany has raised concerns of generation adequacy both in Germany and in Europe in general.[124]

3.1.2.3 Flood of cheap shale gas: Increasing competitiveness of coal power plants

The worsening situation of gas-power plants in Europe in terms of profitability is not only a result of the greater share of intermittent RESs. Coal-power plants have started to become again more profitable due to the so-called shale gas revolution taken place in America. Following the US shale gas revolution, natural gas prices have considerably dropped in the US and therefore many generators have switched from coal to gas.[125] As a side effect of this,

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118 IEA, Energy Policies of IEA Countries: Belgium 2016 Review, *Supra* note 116, p.10.
119 *ibid*.
120 RÜDIG W., 'Phasing out Nuclear Energy in Germany', (2000), *German Politics*, 9:3, pp. 43-80.
121 ZELDIN W., 'Germany: Parliament Extends Life of Nuclear Power Plants', Global Legal Monitor, The Library of Congress, 29.11.2010, <http://www.loc.gov/law/foreign-news/article/germany-parliament-extends-life-of-nuclear-power-plants/> accessed 25.02.2018.
122 BRUNINX K. et al., 'Impact of the German nuclear phase-out on Europe's electricity generation – A comprehensive study', (2013), 60 *Energy Policy*, pp. 251-261.
123 *Ibid.*
124 *Ibid.*
125 CHAZAN G. and WIESMANN G., 'Shale gas boom sparks EU coal revival', Financial Times, 03.02.2013, <http://www.ft.com/cms/s/0/d41c2e8a-6c8d-11e2-953f-00144feab49a.html#axzz38b0mfWkz> accessed 25.02.2018.

American coal has increasingly found its way to Europe where generators are ready to replace expensive natural gas with the cheap coal.[126] This side effect has been monitored in many European countries. For instance, according to a study, the share of natural gas in power generation has sharply decreased since the autumn of 2011.[127] Electricity generated from natural gas and its share in total generation in 2012 was the lowest recorded level over the past 15 years.[128] In a similar vein, as per the same study, coal power generation, which previously accounted for less than half of natural gas power generation, exceeded gas power generation in 2012 in Spain.[129] The electricity generation from (brown) coal in Germany also hit a record last year since 1990, despite the country`s campaign to transition towards green energy.[130] The increasing competitiveness of coal in European power markets against natural gas has even been amplified by low carbon prices in Europe.[131]

3.1.2.4 The Global Financial Crisis 2008

Most countries around the world were exposed to the devastating Global Financial Crisis in 2008. As per many well-known economists, the Global Financial Crisis 2008 was the worst

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[126] *Ibid*.
[127] YANAGISAWA A., 'Impacts of shale gas revolution on natural gas and coal demand: Power generation mixes in both sides of Atlantic swung with natural gas price in the US', The Institute of Energy Economics, Japan, January 2013, <http://eneken.ieej.or.jp/data/4687.pdf>, accessed 25.02.2018, p.7.
[128] *Ibid*.
[129] *ibid*.
[130] WAGSTYL S., 'German coal use at highest level since 1990', Financial Times, 07.01.2014, <http://www.ft.com/cms/s/0/e6470600-77bf-11e3-807e-00144feabdc0.html#axzz38b0mfWkz> accessed 23.09.2014.
[131] European Commission, 'DG Energy: Market Observatory for Energy', *Quarterly Report on European Electricity Markets*, Volume 6, Issue 2, 2013, p. 8; and The Economist, 'Carbon trading: ETS, RIP?', 20.04.2013 <http://www.economist.com/news/finance-and-economics/21576388-failure-reform-europes-carbon-market-will-reverberate-round-world-ets> accessed 26.09.2014.

economic downturn, in terms of severity and length, since the Great Depression in 1929.[132] To understand how huge and deep the economic downturn was, it is sufficient to look at what Yanis Varoufakis, the former Finance Minister of Greece, wrote about it. According to Varoufakis' stimulating book, in this crisis, $40 trillion melted away, $14 trillion of which belonged solely to the US economy.[133] Furthermore, Varoufakis noted that 700,000 US citizens lost their jobs in each month and the number of people that had to sell their houses was beyond measure.[134]

Naturally, this global economic collapse detrimentally affected the development of electricity markets around the world, especially in terms of decreasing power demand. The European electricity markets also suffered from this negative economic trend. Although the demand patterns for electricity have been widely differentiated among the Member States,[135] the growth of electricity demand in Europe decreased or stagnated after 2008. The European Environment Agency put forward that "[w]ithin the EU-28, electricity consumption peaked in 2008, after which it began to decrease. By 2013 it was 3.3% below the 2008 level (before the

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[132] *For instance,* VAROUFAKIS Y.*, The Global Minotaur: America, the True Origins of the Financial Crisis and the Future of the Global Economy,* (in Turkish version), Encore Publications, İstanbul, 2015, p.17; EIGNER P. and UMLAUFT T. S., 'THE Great Depression(s) of 1929-1933 and 2007-2009? Parallels, Differences and Policy Lessons', Hungarian Academy of Science MTA – ELTE Crisis History Research Group, Working Papers in Crisis History No.2, July 2015, <https://poseidon01.ssrn.com/delivery.php?ID=545088089111020079030127123122089120039012007068065003094083109117029101126102117093035043107025020012109114028007123106125015033055024073042105004090010126082093089003009036118086118125004086070089114104029006098084095014117097113088121011102027022094&EXT=pdf> accessed 03.03.2018, p.5; TEMIN P., 'The Great Recession and the Great Depression', National Bureau of Economic Research (NBER) Working Paper No.15645, Cambridge, January 2010*,* <http://www.nber.org/papers/w15645.pdf> accessed 03.03.2018.

[133] VAROUFAKIS Y., *The Global Minotaur: America, the True Origins of the Financial Crisis and the Future of the Global Economy*, *Supra* note 132.

[134] *Ibid*.

[135] *For instance,* according to 2012 statistics published by Eurelectric, some Member States including Bulgaria, Latvia and Malta saw an increasing demand in their electricity markets, respectively 9.8%, 6.9% and 4.5%. On the other hand, electricity demand in Belgium (-8,5%) and Cyprus (-8%) largely decreased between 2011 and 2012. Furthermore, in some big economies such as the UK, Germany, Italy and the Netherlands, the rate of decrease of electricity demand exceeded 2% in the same period while in other electricity markets including Spain and Poland, electricity demand decreased more than 1%. Lastly, in France and Sweden, the demand for electricity increased in the same period. These statistics clearly shows how diverged electricity demand patterns there are in European countries. *See*, EURELECTRIC, 'Power Statistics & Trends 2013', December 2013, <http://www.cold.org.gr/library/downloads/Docs/%CE%95%CE%9A%CE%98%CE%95%CE%A3%CE%97%20EURELECTRIC_.pdf>, accessed 03.03.2018, p.10.

recession), but still above the 1990 level."[136] A more persuasive and recent statistics is provided by the IEA in its WEO 2016 which noted that total electricity demand decreased about 6% between 2008 and 2014 in Europe, with a slow increase in 2015.[137] Furthermore, according to same document, in light of the current projected electricity demand growth, total electricity demand in Europe will reach the level of 2008 only after 2020.[138] This has predictably led to a fall in electricity prices in Europe. On this issue, for instance, Haas et al argued that "[t]he reason for high prices in 2008 in continental Europe was the low hydro availability while the falling prices since 2008 may be attributed to the current European economic crisis."[139] According to an article published at the Economist, wholesale electricity prices in Germany decreased from the level of €80 MWh at peak hours in 2008 to €38 MWh at peak hours in 2013.[140] Since the wholesale electricity prices fell in the same period for most European electricity markets, the profitability of European generators also decreased. Of course, it does not mean that the Global Financial Crisis 2008 was the only or the greatest reason for the declined profitability of the European utilities; and, thus, the triggering reason for the increasing concerns of generation adequacy. At the end of the day, the Global Financial Crisis 2008 is not a structural challenge for the European electricity markets, unlike other challenges mentioned above such as price cap regulations, the increasing share of intermittent RESs in generation mix and low carbon prices. However, it still should be said that the financial crisis has negatively impacted the European electricity markets.

4. Capacity Remuneration Mechanisms in the EU Member States

This part of the chapter tabulates information regarding CRMs implemented in 12 Member States (*See* Table 9 below). Chapter 2 previously covered how different types of CRMs work; therefore, this table is organised to illustrate the main motivations and some brief

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[136] EUROPEAN ENVIRONMENT AGENCY, 'Overview of electricity production and use in Europe', Copenhagen, 2015, <https://www.eea.europa.eu/downloads/e0b4fa54c6e94eff886195f1931ed45e/1481817085/assessment.pdf> accessed 25.02.2018, p.12.

[137] IEA, 'World Energy Outlook 2016', *Supra* note 6, p. 270.

[138] *ibid*.

[139] HAAS R. et al, 'The Growing Impact of Renewable Energy in European Electricity Markets', *Supra* note 56, p.136.

[140] The Economist, 'European Utilities: How to lose half a trillion euros', 15.10.2013, <http://www.economist.com/news/briefing/21587782-europes-electricity-providers-face-existential-threat-how-lose-half-trillion-euros> accessed 19.11.2016.

explanations of the CRMs established in Member States. Out of 12 selected Member States, 11 Member States were chosen in accordance with the State Aid Sector Inquiry conducted by the Commission for CRMs. In addition to these 11 Member States, although the UK was not listed on the Sector Inquiry, it is dealt with here because State Aid decision of the UK Capacity Market was taken by the Commission before the Sector Inquiry was started (*see* Table 9). In the previous chapter, five types of CRMs were analysed: (1) capacity markets; (2) capacity obligations; (3) capacity payments; (4) reliability options; and (5) strategic reserves. In addition to these five types of CRMs, the Commission is talking about two more types of CRMs in its Sector Inquiry. These are interruptibility schemes and tender for new capacity. The Commission defines interruptibility schemes as a subcategory of the strategic reserves type and found that France, Germany, Italy, Ireland, Poland, Portugal and Spain have established this scheme within their jurisdictions.[141] In interruptibility schemes, demand side resources are eligible rather than supply resources. However, the tender for new capacity was to be implemented by four Member States including France, Ireland, Belgium and Croatia.[142] Although they are accepted as a CRM by the European Commission, whether tenders for new capacity can be evaluated as a capacity market should be discussed. It is controversial if tenders for new capacity can solve or overcome generation adequacy concerns in the long term, which are generally implemented on locational based. Table 9, however, briefly mentions these tenders in accordance with the Commission's findings from Sector Inquiry.

[141] European Commission, 'Commission Staff Working Document, Final Report of the Sector Inquiry on Capacity Mechanisms', *Supra* note 39, p.60.
[142] *Ibid*.

Table 9 CRMs in the EU Member States

Countries	Installed Generation Capacity by MS		Types of CRMs	Main Reasons	Explanations
The UK	**Total**	**95,209**	Capacity Market	Based on three reasons: - The missing money problem - Public good characteristic of reliability - Entry barriers in the wholesale market for new capacity	After a series of consultations and assessments, the UK established its centralised capacity market as a part of its Electricity Market Reform to attract more sustainable, low-carbon capacity at the least cost for consumers. The Energy Act 2013 provided an enabling legal framework for the UK Government to develop the necessary regulatory framework to establish and implement CRM. The UK capacity market has opened to generators, demand side measures, interconnectors and alternative capacity resources such as storage technologies.
	Combustible Fuels	57,737			
	Nuclear	9,487			
	Hydro	4,503			
	Wind	14,291			
	Solar PV	9,187			
	Solar Thermal	0			
	Geothermal	0			
	Tide, Wave and Ocean	4			
	Other sources	0			
Germany	**Total**	**204,052**			

	Combustible Fuels	96,967	- Network Reserve and Capacity Reserve - Interruptibility Scheme	- Nuclear phase out - Increasing share of intermittent RESs - Decreasing wholesale electricity prices and, in connection with this, decreasing profitability of conventional power plants - Lack of adequate transmission infrastructure	In Germany, two kinds of strategic reserve were established: Network reserve and capacity reserve. As per the Ordinance on Reserve Capacity Plants entered into force in June 2013, the German Government established its network reserve scheme to deal with reliability concerns. Network reserve is a locational strategic reserve established for southern Germany. Following the closure of nuclear power plants in March 2011, the use of the strategic network reserve became a necessity for ensuring adequate supply of electricity to southern Germany in the 2011-2012 winter period. The agreement for network reserve is concluded between the TSO responsible for the relevant region and operators of the relevant power plants. These power plants can be located outside of Germany such as in Switzerland and the EU if they are technically eligible for participating network reserve and if the relevant authorities of the other countries do not object.
	Nuclear	10,799			
	Hydro	11,399			
	Wind	44,670			
	Solar PV	39,786			
	Solar Thermal	2			
	Geothermal	26			
	Tide, Wave and Ocean	0			
	Other sources	403			

					The second strategic reserve of Germany is called as capacity reserve. This is a country-wide strategic reserve comprising 2 GW capacity which is thought to be activated in 2018. All types of generators including new and existing are eligible for the German capacity reserve.
France	**Total**	129,309	- Capacity Obligations - Tender for new capacity - Interruptibility Scheme	- Missing money problem - Increasing peak demand - Public good characteristic of reliability	- In 2010, pursuant to Law 2010-1488 (NOME Act), France launched a reform for its electricity market. As a part of this reform, a Capacity Obligation Mechanism was established. This Scheme is fundamentally based on a market created for trading capacity certificates and the only de-centralised market wide capacity mechanism among European electricity markets. All forms of capacity resources including demand side resources, existing and new generation investments are
	Combustible Fuels	22,553			
	Nuclear	63,130			
	Hydro	25,278			
	Wind	10,217			
	Solar PV	6,755			
	Solar Thermal	0			
	Geothermal	2			
	Tide, Wave and Ocean	240			

	Other sources	1,134			accepted as eligible to participate to the French Scheme. In this sense, foreign generators and demand-side resources can contribute straightforwardly to the Capacity Obligation Mechanism if neighbouring TSOs and French TSO agree on a cooperation agreement to certify and test a foreign capacity resource. Unless there is such a cooperation agreement among TSOs, relevant interconnectors can sell their certificates prepared based on their de-rated capacity in the French Scheme.
Italy	**Total**	116,955	- Reliability Options - Interruptibility scheme	- Increasing share of intermittent RESs	Italy recently changed its targeted capacity payment mechanism and established a centralised Reliability Options Scheme in 2014 with the aims of improving generation adequacy, coordination of investments and increasing competition. The capacity product auctioned in this scheme is reliability option contracts, a type of contract for difference. While
	Combustible Fuels	65,617			
	Nuclear	0			
	Hydro	22,220			
	Wind	9,187			
	Solar PV	18,892			

	Solar Thermal	0			participation is voluntary based, the Scheme's door opens to both new (planned or under construction) and existing capacity investments as long as they are not intermittent, not granted by any other incentive scheme and not subject to dismantling measures ratified by competent authorities.
	Geothermal	768			
	Tide, Wave and Ocean	0			
	Other sources	321			
Spain	**Total**	106,901	- Capacity Payment - Interruptibility scheme	- Increasing share of intermittent RESs - Increasing demand (this is true for a certain period of time) - Lack of adequate interconnection which exacerbates the	Spain has one of the oldest CRMs in Europe. With the liberalisation of the electricity market in 1997, Spain established capacity payment mechanisms parallel to the energy-only market. Spain has given to two types of capacity payments: (1) An availability-based payment provided for hydropower, gas power, coal-fired and fuel-oil generators regardless of whether they are running or not, and (2) An investment incentive payment provided for generators built after 1997. The Spanish scheme is also open to demand side resources if they are large industrial customers.
	Combustible Fuels	49,350			
	Nuclear	7,399			
	Hydro	20,053			
	Wind	22,943			
	Solar PV	4,856			
	Solar Thermal	2,300			
	Geothermal	0			
	Tide, Wave and Ocean	0			

	Other sources	0		effect of flexibility	There are plenty of critics to the Spanish capacity payment mechanism regarding it design flaws.
Belgium	**Total**	21,146	- Strategic reserve - Tender for new capacity	- Phasing out of nuclear power plants - Increasing share of intermittent RESs - Closure of gas-fired power plants	- Volume of capacity that is auctioned is decided by the Federal Minister of Energy in accordance with the advice of the energy administration and calculations of Elia, the Belgium TSO. Demand side capacity resources are also eligible for the Belgian Strategic Reserve. Elia is responsible for the implementation of this scheme while the ownership of generators remains with the investors. The Belgian Strategic Reserve does not intend to attract new capacity investments, but it targets keeping existing capacity resources online. It seems that the need for strategic reserve in Belgium will increase if the current market deficiencies continues to be on the table. - In 2014, Belgium launched a tender to attract 700-900 MW of gas power plant.
	Combustible Fuels	8,509			
	Nuclear	5,913			
	Hydro	1,422			
	Wind	2,176			
	Solar PV	3,122			
	Solar Thermal	0			
	Geothermal	0			
	Tide, Wave and Ocean	0			
	Other sources	4			

					Yet, the tender was cancelled in 2015 in accordance with the Commission’s decision.
Portugal	**Total**	19,625	- Capacity payment - Interruptibility scheme		Portugal established a Capacity Payment Mechanism in 2010. Like Spain, Portugal designed two types of capacity payments: (1) An availability-based scheme provided for thermal power plants in return for their availability, (2) An investment incentive scheme provided for new hydro investments and the repowering of existing pump storage units. On 28 December 2016, article 169 of Law no. 42/2016, which approved the State Budget for 2017, cancelled availability-based capacity payments provided for thermal plants being valid from 1 January 2017 and appointed the Government to form a market-based mechanism to
	Combustible Fuels	8,048			
	Nuclear	0			
	Hydro	6,168			
	Wind	4,937			
	Solar PV	447			
	Solar Thermal	0			
	Geothermal	25			

	Tide, Wave and Ocean	0			exclusively reward the availability product supplied by generators. The updated scheme was ratified by Ministerial Order no. 41/2017, of 27 January. It forecasts that availability is remunerated through competitive and transparent auctions for that all generators that are equal or higher than 10 MW and, in some circumstances, demand side resources may participate.
	Other sources	0			
Denmark	**Total**	14,005	Strategic Reserve	Based on three combined reasons: - Increasing Peak Demand - Expectation of closing power plants	The Danish TSO, Energinet.dk, has intended to implement 300 MW strategic reserve between 2016 and 2020 to deal with the increasing capacity cap towards 2024. Strategic Reserve in Denmark is designed to allow the participation of both supply and demand side capacity resources. Actually, investing in additional interconnector capacity between East and West Denmark was thought of as another solution to deal with the generation
	Combustible Fuels	8,141			
	Nuclear	0			
	Hydro	7			
	Wind	5,075			
	Solar PV	782			
	Solar Thermal	0			

	Geothermal	0		- Increasing share of RESs (Flexibility)	adequacy problem; however, since this solution would take a long-time, a 300 MW Strategic Reserve was considered to be implemented as an interim solution between 2016 and 2020.
	Tide, Wave and Ocean	0			
	Other sources	0			
Ireland		9,557	- Reliability Options - Tender for new capacity - Interruptibility scheme		- Ireland has implemented a Capacity Payment Mechanism for a long time. Yet, Ireland changed the Capacity Payment Mechanism with Reliability Options in 2017. A Reliability Options Mechanism is designed for resources placed in both the Republic of Ireland and Northern Ireland with the name of Integrated-Single Electricity Market (I-SEM). The Commission recently approved the new Reliability Options to be jointly
	Combustible Fuels	6,586			
	Nuclear	0			
	Hydro	529			
	Wind	2,440			
	Solar PV	2			
	Solar Thermal	0			

	Geothermal	0			implemented in the Irish and Northern Irish electricity markets. On this issue, Commissioner Margrethe Vestager, responsible for competition policy, noted: *"The joint Irish and Northern Irish capacity mechanism will help ensure security of electricity supply in the years to come. I think it is a good thing that this mechanism is operated across national borders and fosters competition among all potential capacity providers, to the benefit of consumers."* Supply and demand side capacity resources can participate in the I-SEM Reliability Options and interconnectors need to be qualified to participate in capacity auctions. - In 2003, Ireland organised a tender with the expectation of a capacity shortage from 2005 onwards. With this auction, a new CHP facility and a new gas power plant which are
	Tide, Wave and Ocean	0			
	Other sources	0			

					over 500 MW together were established in 2005 and 2006.
Sweden	**Total**	39,712	Strategic Reserve	Based on different reasons: - Need for heating during extremely cold weather periods in winters - Decommissioning nuclear power plant in 1999 and 2002 - Lack of adequate commercial incentives	With the Peak Load Reserve Act (2003:436), a Strategic Reserve was established under the responsibility of Svenska Kraftnät, the Swedish TSO, in 2003. According to this Act, Svenska Kraftnät must make 2 GW capacity available during winter to meet peak load. Later on, the reserve level decreased to 1 GW. Normally, the Swedish Strategic Reserve will be removed after the 2019/2020 winter, however it will now be extended until 2025 with 750 MW contracted reserve for the period of 2017 and 2025. The Strategic Reserve in Sweden is open to both supply and demand side capacity resources. Since 2003, the Strategic Reserve Mechanism has had to be activated several times in 2004/2005 (partly activated), 2006/2007 (activated
	Combustible Fuels	7,751			
	Nuclear	9,688			
	Hydro	16,329			
	Wind	5,840			
	Solar PV	104			
	Solar Thermal	0			
	Geothermal	0			
	Tide, Wave and Ocean	0			
	Other sources	0			

					due to net problems), 2009/2010 (activated 3 times), 2011/2012 (activated 5 times) and 2012/2013 (activated one time).
Croatia	**Total**	4,798	Tender for new capacity	Attracting new investment	In Croatia, the State-owned energy company Hrvatska elektroprivreda (HEP) organised a tender in 2012 to attract a new 515 MW coal power plant at Plomin on the Adriatic coast. The tender in Croatia was only open to coal capacity (i.e. closed to other technologies such as gas power plants or demand side resources) at a specific coastal site where coal can be imported.
	Combustible Fuels	2,124			
	Nuclear	0			
	Hydro	2,208			
	Wind	418			
	Solar PV	48			
	Solar Thermal	0			
	Geothermal	0			
	Tide, Wave and Ocean	0			
	Other sources	0			

Poland	**Total**	37,322	- Capacity Market - Interruptibility scheme	- Increasing capacity gap - Providing incentives for new investments, extending operational life of existing generators, promoting demand side resources and stabilising intermittent RESs with conventional power plants.	Poland established a Strategic Reserve involving 830 MW generation capacity (the Polish Strategic Reserve did not open to demand-side resources) as a two-ear transitional mechanism started in 2016. After implementing a transitory strategic reserve mechanism, Poland is intending to establish a capacity market which is similar to the UK Capacity Market. The Polish Capacity Market will be open to generators, storage facilities and demand-side resources as capacity providers. The Lower House of the Polish Parliament approved the Polish Capacity Market on 6 December 2017 and now it goes to the Senate. The first auction for capacity in Poland is intended to be held in December 2018.
	Combustible Fuels	29,956			
	Nuclear	0			
	Hydro	2,370			
	Wind	4,886			
	Solar PV	108			
	Solar Thermal	0			
	Geothermal	0			
	Tide, Wave and Ocean	0			
	Other sources	2			

(Prepared by the author based on the following sources: European Commission, Energy Data & Analysis By Country, *Supra* note 77; WILLIS P., 'United Kingdom' in HANCHER L. et al (eds), *Capacity Mechanisms in the EU Energy Market: Law, Policy and Economics,* Oxford University Press, UK, 2015; Ofgem, 'Capacity Market (CM) Rules' <https://www.ofgem.gov.uk/electricity/wholesale-market/market-efficiency-review-and-reform/electricity-market-reform/capacity-market-cm-rules> accessed 28.02.2018; PRITZCHE K. U. and REINHARDT K., 'Germany' in HANCHER L. et al (eds), *Capacity*

Mechanisms in the EU Energy Market: Law, Policy and Economics, Oxford University Press, UK, 2015; European Commission, 'Commission Staff Working Document, Final Report of the Sector Inquiry on Capacity Mechanisms', *Supra* note 44; Rte (The French Transmission System Operator), 'French Capacity Market: Report accompanying the draft rules', 09.04.2014 < http://www.rte-france.com/sites/default/files/2014_04_09_french_capacity_market.pdf> accessed 28.02.2018; TERNA (The Italian TSO), 'Italian Capacity Market', Bruxelles, 14.04.2015, <http://ec.europa.eu/competition/sectors/energy/capacity_mechanisms_working_group_12.pdf> accessed 25.02.2018; IEEFA (Institute for Energy Economics and Financial Analysis), 'Spain's Capacity Market: Energy Security or Subsidy?', December 2016, <http://ieefa.org/wp-content/uploads/2017/11/Spains-Capacity-Market-Energy-Security-or-Subsidy_December-2016.pdf> accessed 26.02.2018; CLERCQ B. E., 'Electricity security crisis in Belgium', Elia (The Belgium TSO), 15.01.2015, <https://www.iea.org/media/workshops/2015/esapworkshopv/deClercq.pdf> accessed 25.02.2018; ENERDATA, 'Belgium cancels gas-fired power project tender' 31.03.2015, <https://www.enerdata.net/publications/daily-energy-news/belgium-cancels-gas-fired-power-project-tender.html> accessed 25.02.2018; FAURE A., STANKOVIĆ A. T. and JAKŠIĆ D., 'Electricity Security of supply and Capacity Remuneration Schemes', INSIGHT_E, September 2016, <http://www.insightenergy.org/system/publication_files/files/000/000/052/original/HET17_Final.pdf?1477554191> accessed 25.02.2018; PACHECO M. C. and MENDES J. (CMS Rui Pena & Arnaut), 'Energy 2018 – Portugal', Global Legal Insights, <https://www.globallegalinsights.com/practice-areas/energy-laws-and-regulations/portugal> accessed 25.02.2018; ENERGITILSYNET (The Danish Energy Regulatory Authority), 'Strategic reserves in Eastern Denmark', <http://energitilsynet.dk/fileadmin/Filer/Internationalt/Hoeringer/Strategic_reserves_in_Eastern_Denmark_v_1.pdf> accessed 25.02.2018; European Commission, 'State aid: Commission approves joint capacity mechanism for Ireland and Northern Ireland', Press Release, 24.11.2017, <http://europa.eu/rapid/press-release_IP-17-4944_en.htm > accessed 25.02.2018; CEJIE J. 'The Strategic Reserve – Why and How?', Government of Sweden, Ministry of the Environment and Energy Sweden, <http://ec.europa.eu/competition/sectors/energy/strategic_reserve_en.pdf> accessed 25.02.2018; SWEDISH ENERGY AGENCY, 'The Swedish Energy Markets Inspectorate's report in accordance with the EC Directives for the internal markets for electricity and natural gas 2007, A report from the Energy Markets Inspectorate', <https://www.ceer.eu/documents/104400/-/-/fb227613-6dc2-4a16-8ebd-1402c513fc8c> accessed 25.02.2018; COMPASS LEXECON, 'Assessment of the impact of the Polish capacity mechanism on electricity markets, A Report for the Polish Electricity Association', Polish Electricity Association (PKEE), 11.09.2017, <http://www.pkee.pl/upload/files/A_Report_for_the_Polish_Electricity_Association_FTI.pdf> accessed 25.02.2018; CICHOCKI K. et al, 'Polish model of Capacity Market', SK&S Legal, 18.08.2017, <https://skslegal.pl/wp-content/uploads/2017/09/Zalozenia_rynku_mocy_23_sierpien_2017_EN_clean-final.pdf> accessed 25.02.2018; EASTON A., 'Poland's lower house of parliament approves capacity market' S&P Global, 06.12.2017, <https://www.platts.com/latest-news/coal/warsaw/polands-lower-house-of-parliament-approves-capacity-26852430> accessed 25.02.2018).

5. Conclusion

This chapter explored the reasons for the emergence of rapidly spreading CRMs in European electricity markets in recent years. Having drawn a general picture of European CRMs, this chapter mainly aimed to find answers to such questions as the reasons for the rapid expansion of CRMs in Europe, whether there are overlapping reasons with the Conceptual Framework presented in the previous chapter and whether there are European-specific reasons. As a result, on the one hand, it has been revealed that the reasons for the establishment of European capacity markets are in line with the Conceptual Framework to a large extent. On the other hand, there are European specific reasons that have led to the establishment of CRMs.

This chapter confirms that the liberalisation of electricity markets in Europe produced challenges for ensuring generation adequacy. There have been rising concerns in Europe regarding the capability of energy-only markets to provide adequate security of supply. Accordingly, many European governments have introduced CRMs in their jurisdictions with a unilateral approach. It is known, however, that fragmented and uncoordinated CRMs in integrated electricity markets, as in Europe, might cause inefficiencies and distort cross-border trade. These developments raise the controversial issue of creating a regulatory framework to integrate CRMs in Europe.

CHAPTER 4 - INTEGRATION OF EUROPEAN CRMs: AN ATTEMPT TO CREATE A REGULATORY FRAMEWORK

1. Introduction

The previous chapter analysed three basic issues: (1) The historical background of liberalisation in EU electricity markets; (2) Why CRMs have emerged in Member States; and (3) What types of CRMs have been established in different European countries. As shown Chapter 3, electricity market reform in the Member States in accordance with EU legislation aimed to create energy-only markets in Member State jurisdictions. However, due to regulatory and market failures including the missing money problem and other challenges that exacerbated the effect of missing money problem such as the increasing share of intermittent solar and wind power in generation mixes, generation adequacy has been at risk in a number of Member States. Chapter 3 was mainly dedicated to discussing the reasons that led to the adoption of CRMs in Member States.

As discussed in the previous chapter, EU Energy Policy has historically been based on three core objectives: competitiveness, security of supply and sustainability.[1] It is a well-known fact that these objectives are not always in harmony; on the contrary, they may occasionally conflict with each other.[2] In line with this issue, one of the main concerns regarding CRMs is that they may aggravate conflicts among these core policy objectives. For instance, the Commission has put forward its worries regarding this issue by indicating that CRMs may favour fossil-based generators rather than intermittent renewable energy sources and may thus be in conflict with EU decarbonisation and resource efficiency objectives.[3] The

[1] European Commission, 'Green Paper: A European Strategy for Sustainable, Competitive and Secure Energy', Brussels, 08.03.2006, COM(2006) 105 final, <http://europa.eu/documents/comm/green_papers/pdf/com2006_105_en.pdf> accessed 14.02.2013.

[2] For instance, *See*, KEAY M., 'The EU "Target Model" for electricity markets: fit for purpose?', Oxford Energy Comment, The Oxford Institute for Energy Studies, May 2013, <https://www.oxfordenergy.org/wpcms/wp-content/uploads/2013/05/The-EU-Target-Model-for-electricity-markets-fit-for-purpose.pdf> accessed 23.10.2016.

[3] European Commission, 'Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Making the Internal Energy Market Work', Brussels, 15.11.2012, COM(2012) 663 final, <http://eur-

Commission has also stated that capacity markets will increase electricity prices, thus adversely affecting the competitiveness of European markets. At this juncture, it may be useful to analyse how CRMs interact with the abovementioned policy priorities:

- *Security of supply:* The main objective of CRMs is directly related to ensuring security of supply in the long-run. This objective is legitimate for all Member States. However, if governments did not develop their CRMs in harmony with adjacent markets, capacity mechanisms would isolate national markets. Obviously, this does not comply with EU Energy Policy aimed at creating an internal market. The Commission, on this issue, notes that "[…], the system reliability in interconnected markets is interdependent."[4]
- *Competitiveness:* CRMs have impacts on both availability, which is directly about security of supply, and electricity prices, which is related to competitiveness. Thus, there exist widespread doubts concerning how CRMs may affect the competitiveness of the EU. According to the Commission, energy costs are a strategic aspect for the competitiveness of energy-intensive sectors.[5] Furthermore, the Commission defines rising electricity prices in the EU far much more than the US in the last 7 years as one of the key energy challenges of the EU from the perspective of competitiveness.[6] These concerns are legitimate because it is a fact that if not well-designed, CRMs, especially those that are market-wide such as capacity markets, may increase electricity prices. However, as long as they are designed in a proper way, their costs must not exceed the costs normally experienced in energy-only markets. The only cost difference between electricity markets complemented with a CRM and an energy-only market should stem from the increasing reserve margin which is a deliberate result of a CRM. However, this cost difference is not huge. For instance, according to research

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lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52012DC0663&from=EN> accessed 26.02.2018, p.15.

[4] European Commission, 'Communication from the Commission: Delivering the Internal Electricity Market And Making the Most of Public Intervention', Brussels, 05.11.2013 C(2013) 7243 final, <https://ec.europa.eu/energy/sites/ener/files/documents/com_2013_public_intervention_en.pdf> accessed 26.02.2018, p.12.

[5] *ibid*, p.11.

[6] European Commission, 'Energy challenges and policy: Commission contribution to the European Council', 22.05.2013.

prepared for the Federal Energy Regulatory Commission (FERC), if a reserve margin increased from 7.9% to 15.2% due to the implementation a capacity market, average customer costs would only rise by 1.5%.[7] According to the abovementioned research, the increase in total customer cost with the rising reserve margin is quite small since "increasing the reserve margin with a capacity market not only introduces capacity costs but also reduces energy-related costs, a factor which is not considered in many discussions."[8]

- *Sustainability:* CRMs may contradict with the environmental aspects of energy policy in unpredictable ways.[9] The Commission put forward its worries regarding the potentially detrimental effect of CRMs on climate change objectives.[10] These concerns have also been expressed in a range of different researches as well, especially in connection with subsidising coal power plants. For instance, Littlecott criticises the UK forward capacity market by claiming that it is in contradiction with climate change policy because it supports old coal-power plants through illegal subsidies.[11] Additionally, Jenny Banks, an energy and climate change specialist at WWF-UK noted that the UK capacity market may push electricity prices up and retard UK climate change goals by throwing money at existing coal plants in the UK.[12] Criticisms, of course, are not only for market wide capacity markets, but also target strategic reserve which may favour old fossil-based generators as reserve capacity. Although these criticisms can be seen as legitimate, it should be noted that they ignore the

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[7] PFEIFENBERGER J. P., SPEES K., CARDEN K. and WINTERMANTEL N., 'Resource Adequacy Requirements: Reliability and Economic Implications', The Brattle Group and Astrape Consulting, September 2013, p.104.

[8] *ibid.*

[9] See, CALDECOTT B. and MCDANIELS J., 'Stranded generation assets: Implications for European capacity mechanisms, energy markets and climate policy', Working Paper, Smith School of Enterprise and the Environment, University of Oxford, January 2014, <http://www.smithschool.ox.ac.uk/research/sustainable-finance/publications/Stranded-Generation-Assets.pdf> accessed 11.02.2016, p.33.

[10] *See*, European Commission, 'Communication from the Commission: Delivering the internal electricity market and making the most of public intervention', *Supra* note 4, p.8.

[11] LITTLECOTT C., 'Keeping coal alive and kicking: Hidden subsidies and preferential treatment in the UK Capacity Market', E3G, Briefing Paper, July 2014, <https://www.e3g.org/docs/E3G_Briefing_-_Keeping_coal_alive_and_kicking_-_hidden_subsidies_and_preferential_treatment_in_the_UK_capacity_market.pdf> accessed 26.02.2018.

[12] WWF, 'Capacity market decision green lights dirty coal use for another generation', <http://www.wwf.org.uk/about_wwf/press_centre/?unewsid=7276> accessed 28.09.2014.

adaptability of, especially, forward capacity markets to climate change objectives. PJM and ISO-NE forward capacity markets can be shown as examples of this. These capacity markets have shown their ability to sustain generation adequacy despite the existence of tightening U.S. Federal and State Environmental Regulations, particularly the Mercury and Air Toxic Standards, which have forced a significant member of generators to make retire-or-retrofit decisions.[13] This shows that as long as the right type of CRM is chosen and it is designed properly, there is no need for conflict to arise between the implementation of capacity mechanisms and climate change objectives.

As can be seen from the discussion above, implementing CRMs can be contrary to other policy objectives including competitiveness, sustainability and security of supply. However, it is clear that appropriately designed capacity mechanisms may overcome these challenges. Therefore, the Commission states that "when designing public intervention, Member States should avoid addressing different public policy objectives in isolation from each other, in order to avoid a conflict between them. They should plan holistically, taking into account all objectives of energy policy and need to coordinate the various instruments of public intervention, including opportunities offered by internal electricity market."[14]

This chapter asks a crucial question for the future of the EU Electricity Markets: What regulatory framework is required for EU Electricity Markets so as to integrate European CRMs? The integration of European CRMs is of paramount importance since it is the only way to reduce policy conflicts among European energy policy objectives. Further, this chapter will show that integrating European CRMs will provide the chance for Member States to reach their generation adequacy objectives in a significantly cheaper and cleaner way. This part of the thesis will commence with the definition of the integration CRMs. The definition of the integration of CRMs here is made from different perspectives Following the discussing of the definition of different types of integration, this chapter will extensively address why the integration of CRMs in the EU is a necessity from a legal and economic perspective. First, State

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[13] SPEES K., NEWELL S. and PFEIFENBERGER J. P., 'Capacity Markets – Lessons Learned from the First Decade', 2 *Economics of Energy & Environmental Policy*, September 2013, p.167.
[14] *See*, European Commission, 'Communication from the Commission: Delivering the internal electricity market and making the most of public intervention', *Supra* note 4, p.8.

Aid Rules are dealt with as a first legal justification that imposes the integration of European CRMs. State Aid Rules within the context of CRMs are examined from both theoretical and practical approaches. With this understanding, several State Aid cases related to European CRMs will be carried out. Following State Aid Rules, the Free Movement of Goods will be discussed as the second legal justification for integrating European CRMs. Economic justifications for integration starts by analysing the benefit of national differences in terms of generation mixes and weather conditions. As a second justification from an economic perspective, this chapter will also discuss how the integration of European CRMs may reduce the detrimental effects of unilaterally implemented CRMs.

Subsequently, a regulatory framework is proposed in order to show what minimum requirements for capacity trading across borders should be met. This regulatory framework includes four conditions: (1) Harmonised Generation Adequacy Assessments; (2) Respecting Contracted Capacity Obligations; (3) Allocation of Interconnectors' Capacity; and (4) No Double Counting. After putting forward this proposal, the relationship between the Energy Union Strategy and the issue of the integration of European CRMs is addressed.

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2. What is the integration of CRMs?

The integration of European CRMs in this study is defined as accepting foreign capacity resources to national CRMs. This can be brought about through allowing cross-border participation, where physically possible. Creating a well-integrated market has been regarded as a strategic target for the European integration process ever since the adoption in 1957 of the Treaty of Rome. This is also true for the aim of establishing an internal energy market (IEM). It is obvious that generation adequacy, or more generally speaking, security of supply in integrated European electricity markets is beyond being a purely national concern, but should be tackled on a regional and European level.[15] This may be considered as a natural and expected consequence of decades-long endeavours to create a single European electricity market. It is not plausible to think of an IEM without relying on cross-border resources to ensure generation adequacy. For instance, this argument is expressly raised by Rte, the French Transmission System Operator (TSO), in its recent generation adequacy report:

> "Analysis of the country on a 'standalone' basis […] shows just how vital imports are to ensuring security of supply in France, with exchanges contributing about 8 to 10 GW over the coming years. The expansion of interconnection capacity in the years ahead […], along with the availability of capacities in foreign countries […], explains why this contribution is so high. Based on current domestic demand in France and the changes being made to the generation mix, France would not be able to balance electricity supply and demand on its own."[16]

However, unilateral CRMs that have rapidly proliferated around Member States in recent years are in contradiction to this approach. Integrating unilateral CRMs, therefore, must happen in order to preserve the IEM and its benefits, though this is not an easy task. The question of how this integration can be realised stands as one of the most difficult challenges facing energy policy makers in Europe. Different levels of integration can be considered as follows:

- Creating a single European CRM or establishing regional-wide CRMs
- Allowing cross-border participation implicitly or explicitly

[15] ACER, 'Report on Capacity Remuneration Mechanisms and the Internal Market for Electricity', 30.07.2013, <http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/CRMs%20and%20the%20IEM%20Report%20130730.pdf> accessed 27.02.2018, p. 15.

[16] RTE, 'Generation Adequacy Report on the Electricity Supply-Demand Balance in France', 2014 Edition <http://www.rte-france.com/sites/default/files/2014_generation_adequacy_report.pdf> accessed 27.05.2015, p.116.

The first option, an entirely integrated CRM at the European level (i.e. creating a single European CRM) seems dysfunctional since motivations for European countries to establish CRMs are based on considerably diverse needs.[17] These arise from their individual energy market structures, different objectives and concerns. Differences in needs and objectives are even valid for neighbouring energy markets in Europe. For instance, while France introduced its capacity mechanism to deal with the missing money problem for peak plants and low profitability of gas power plants, the UK aims to attract adequate investment and provide flexibility.[18] Furthermore, whereas Spain aims at coping with low profitability of gas power plants as well as providing flexibility, Italy intends to coordinate generation and network investments, and provide flexibility.[19] Due to such substantial differences, the designs of CRMs in Member States have become far from homogenous: from targeted mechanisms, such as the strategic reserve in Belgium, to market-wide mechanisms, such as capacity obligations in France, forward capacity auctions in the UK, and reliability options in Italy. Thus, establishing either a single European CRM or regional CRMs appears to be a remote possibility, at least for the time being.

Therefore, out of the two integration options specified above, allowing cross-border participation implicitly or explicitly to national CRMs seems the more realistic option.

2.1 Implicit Cross-border Participation

The implicit contribution of cross-border capacity is based upon "the procurement process on the domestic resources, while taking into account the statistical contribution […] of all the cross-border resources to national generation adequacy."[20] In the absence of explicit participation of cross-border resources in national CRMs, this approach is supported by the Commission as an interim solution to calculate the contribution of imports to national

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[17] MASTROPIETRO P. et al, 'National capacity mechanisms in the European internal energy market: Opening the doors to neighbours', (2015), 82 *Energy Policy*, pp 38.47, p.39-40.

[18] ROQUES F., 'Capacity Remuneration Coordinating European Capacity Mechanisms: Which Way Forward?', EPRG Spring Seminar, Cambridge, 16.05.2014 <http://www.eprg.group.cam.ac.uk/wp-content/uploads/2014/05/EPRG_Roques_May2014_final.pdf> accessed 28.05.2015.

[19] *ibid.*

[20] HENRIOT A. and GLACHANT J. M., 'Capacity Mechanisms in the European Market: Now, but How?', in HANCHER L. et al (eds), *Capacity Mechanisms in the EU Energy Market: Law, Policy and Economics*, Oxford University Press, UK, 2015, p.4.

generation adequacy standards.[21] It is effectively working by excluding generators located abroad from national CRMs, but factoring their contribution into generation adequacy.[22] The UK (for the first auction in 2014) and France have adopted this approach to reduce their domestic capacity needs and, hence, decrease the costs of overcapacity. At first glance, the implementation of this method seems simple. However, due to lack of coordination among Member States regarding regional and Europe-wide generation adequacy assessments and highly variable contributions of interconnectors, estimating the real contribution of cross-border capacities during stress events can be quite difficult.[23] Thus, developing an enabling regulatory framework is required to facilitate even implicit cross-border participation.

2.2 Explicit Cross-border Participation

Explicit cross-border participation simply means allowing capacity resources located abroad to bid into national CRMs with the same obligations as domestic capacity resources. The maximum foreign capacity that can bid into a national CRM should be limited by the capacity of the interconnector. In this approach, interconnector owner, by definition TSOs, would collect the revenues based on the price differences between foreign and national capacity bids.[24] This approach is fully supported and is seen as an ultimate goal by the Commission, the Agency for the Cooperation of Energy Regulators (ACER), Eurelectric, and Member States such as France and the UK. Within this scope, the Commission clearly indicated that "[m]echanisms to ensure generation adequacy should be open to all capacity which can effectively contribute to meeting the required generation adequacy standard, including from other Member States."[25] Furthermore, ACER supported the explicit cross-border participation

[21] European Commission, 'Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Making the Internal Energy Market Work', *Supra* note 3, p.30.
[22] BARITAUD M. and VOLK D., 'Seamless Power Markets: Regional Integration of Electricity Markets in IEA Member Countries', OECD/IEA, Paris, 2014, <http://www.iea.org/publications/freepublications/publication/SEAMLESSPOWERMARKETS.pdf> accessed 29.05.2015, p.72.
[23] HENRIOT A. and GLACHANT J. M., 'Capacity Mechanisms in the European Market: Now, but How?', *Supra* note 20, p.4.
[24] SWECO, 'Capacity Markets in Europe: Impacts on Trade and Investments', A Sweco Multiclient Study, February 2014, <https://www.e-control.at/documents/20903/-/-/14dcbb37-3281-4478-8536-0e7ff85a15af> accessed 21.09.2014, p.36.
[25] European Commission, 'Communication from the Commission: Delivering the Internal Electricity Market and Making the Most of Public Intervention', *Supra* note 4, p.14.

by stating that "in the case of national CRMs, greater efficiency could be achieved and the distortion of the IEM minimised by assuring participation -to the extent possible- of adequacy and system flexibility resources provided by generators and load in other jurisdiction."[26] Eurelectric also advocated the requirement of explicit cross-border capacity participation and proposed some options for it.[27] Although all these leading institutions and stakeholders fully support explicit cross-border participation to ensure generation adequacy with higher efficiency and lower costs, they all accept that it has many and highly complicated challenges to be overcome.

3. Justifications for Integration

3.1 Legal Justifications

The integration of European CRMs from a legal point of view can be justified from two core principles of the EU Law: State Aid rules and the Free Movement of Goods. Before discussing these principles to justify the integration of European CRMs, what the EU *acquis* says concerning the establishment of CRMs in the Member States will be discussed.

3.1.1 Legal Framework for CRMs in the EU

The EU *acquis* permits Member States to establish their own CRMs to ensure generation adequacy in their jurisdictions. The EU legal framework that deals with the issue of generation adequacy, and thus CRMs, consists of the provisions of the Treaty on the Functioning of the European Union (TFEU)[28], Security of Electricity Supply Directive[29] and Electricity Directive[30]. This framework is analysed below.

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[26] ACER, 'Report on Capacity Remuneration Mechanisms and the Internal Market for Electricity', *Supra* note 15, p.16.

[27] FEUK H., 'Options for coordinating different capacity mechanisms', Eurelectric, 12.12.2013, <http://www3.eurelectric.org/media/115222/FEUK.pdf> accessed 26.02.2018.

[28] Consolidated version of the Treaty on the Functioning of the European Union, OJ C 326, 26.10.2012.

[29] Directive 2005/89/EC of the European Parliament and of the Council of 18 January 2006 concerning measures to safeguard security of electricity supply and infrastructure investment, (Text with EEA relevance), OJ L33, 04.02.2006, pp.22-27.

[30] Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC (Text with EEA relevance), OJ L 211, 14.8.2009, pp.55-93.

3.1.1.1 The TFEU

Article 194 (1) of the TFEU indicates that EU energy policy should aim to "(a) ensure the functioning of the energy market, (b) ensure security of energy supply in the Union, (c) promote energy efficiency and energy saving and the development of new and renewable energy forms, (d) promote the interconnection of energy networks."[31] As can be seen from Article 194(1)(b), one of the core elements of EU energy policy is directly related to aiming for security of energy supply. According to Article 194(2) of TFEU, it is further stated that "the European Parliament and the Council, acting in accordance with the ordinary legislative procedure, shall establish the measures necessary to achieve the objectives in paragraph 1."[32]

At this point, it could be asked whether or not CRMs should be organised at the EU level as a requirement of Article 194(2) of TFEU. This is a reasonable question because the wording of the aforementioned clause necessitates the actions of the European Parliament and the Council to reach the objectives specified by Article 194(1), which includes ensuring security of energy supply in the Union. However, as rightly referred by Matthes *et al*.,[33] Article 4(2) of the TFEU defines the issue of energy as a shared competence[34] between the Member States

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[31] Article 194(1) of the TFEU, *Supra* note 28.
[32] *ibid*.
[33] MATTHES F. C. et al., 'Focused capacity markets: A new market design for the transition to a new energy system', A short version of the study for the WWF Germany environmental foundation, Öko-Institut e.V., Berlin, 8 October 2012, <http://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/focused_capacity_market_ENG_short.pdf> accessed 27.02.2018, p. 78.
[34] The Commission can act only within the limits of the competences drawn by the TFEU, which is called as *principle of conferral*. According to this principle, unless there is explicit competences in the Treaty for any area conferred on the Commission, Member States will continue to be the only sovereign authority on that area. Within this understanding, the competences conferred on the Commission through the TFEU are divided into three categories: (1) Exclusive Competences (Article 3 of TFEU): As can be understood from its name, exclusive competences defines areas such as customs union, establishing the competition rules required for the functioning of the internal market, monetary policy, common commercial policy and conclusion of international agreements under certain conditions where the Commission can alone be able to create legislation and binding rules. (2) Shared Competences (Article 4 of TFEU): Shared Competences defines areas such as internal market, social policy, regional policy, agriculture and fisheries, environment, consumer protection, transport, trans-European networks, energy, area of freedom, security and justice, public health issues defined by the TFEU, research and technological development, development cooperation and humanitarian aid where both the Commission and Member States can make legislation and create legally binding rules. Here, the crucial point is that Member States can use their shared competences if the Commission does not use, or has decided not to use, its own competence. Within the context of discussions regarding CRMs, since the Commission has not developed any policy directly related

and the Union. According to Article 2(2) of the TFEU, "[t]he Member States shall exercise their competence to the extent that the Union has not exercised its competence. The Member States shall again exercise their competence to the extent that the Union has decided to cease exercising its competence."[35] As can be understood from these Articles, the issue of security of supply is under the responsibility and authority of national governments. Therefore, it can be said that introducing CRMs are not contrary to the TFEU.[36]

3.1.1.2 The Electricity Directive

The Electricity Directive 2009 ("Electricity Directive" or "the Directive") provides a legal framework for generation investments. As a basic rule, Article 7 of the Directive envisages an authorisation procedure for Member States for the construction of generating capacity, which must be maintained in an objective, transparent, and non-discriminatory way.[37] However, the Directive allows Member States to deviate from this basic rule with two other options provided by Article 8 and Article 3 of the Directive. Article 8(1) allows Member States, for the sake of security of supply, to conduct public tenders or "any procedure equivalent in terms of transparency and non-discrimination" for the construction of generation capacity, if the authorisation procedure provided is insufficient. The Commission interpreted the expression of "any procedure equivalent in terms of transparency and non-discrimination" as strategic reserve, capacity payments, capacity requirements, reliability contracts, and capacity subscriptions in its own note.[38] The other option to derogate from the authorisation

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to generation adequacy, Member States have started to establish their own CRMs in their jurisdictions by exercising their shared competences. (3) Supporting Competences (Article 6 of TFEU): Support in competences defines areas such as protection and improvement of human health, industry, culture, education, tourism, çivil protection and administrative protection where the Commission can only participate to support, coordinate or complement the policies of Member States. *See* EUR-LEX Access to European Union Law, 'Division of competences within the European Union', <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Aai0020> accessed 24.09.2017.

[35] *See,* Article 2(2) of the TFEU, *Supra* note 28.

[36] The State aid provisions, Article 107, 108 and 109, of the TFEU directly relate to CRMs and the issue of State aid is one of the most complex challenges regarding these mechanisms. This issue is therefore dealt with separately in depth below.

[37] *See*, Article 7 of the Electricity Directive, *Supra* note 30.

[38] European Commission, 'Note of DG Energy & Transport on Directives 2003/54/EC and 2003/55/EC on the Internal Market in Electricity and Natural Gas – Measures to Secure Electricity Supply', 16.01.2004, pp. 6-7.

procedure is provided by Article 3 of the Electricity Directive.[39] As per Article 3(2) of the Directive, Member States may impose public service obligations on electricity undertakings in the general economic interest to ensure security of supply.[40] It states further on that these obligations must be clearly defined, transparent, non-discriminatory and verifiable.[41] Public service obligations amount to "specific requirements that are imposed by public authorities on the provider of the service in order to ensure that certain public interest objectives are met, for instance, in the matter of air, rail and road transport and energy."[42] According to the Commission Decision in the Irish CADA Case analysed in more detail below, security of electricity supply is a legitimate aim of general economic interest.[43] Pursuant to this justification, the Commission accepted the capacity payment mechanism implemented in Ireland as a public service obligation.[44] For instance, it seems that France has adopted this approach to justify its CRM.[45]

3.1.1.3 The Security of Electricity Supply Directive

The Security of Supply Directive, in addition to the general provisions mentioned above, deals with the issue of CRMs in the context of generation adequacy. The Recital 1 of the Security of Electricity Supply Directive regards the guarantee of a high level of security of electricity supply as a crucial aim for the effective operation of the internal market.[46] In accordance with the spirit of this Recital, Article 1 of the Security of the said Directive correlates between safeguarding security of supply and ensuring the proper functioning of the IEM. Furthermore,

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[39] *See*, Article 3 of the Electricity Directive, *Supra* note 30.
[40] *ibid.*
[41] *ibid.*
[42] KROPE T. and KROPE J., 'Liberalising Energy in Europe: Public Service Obligations in the Energy Sector', Proceedings of the 2nd IASME/WSEAS International Conference on Energy & Environment, Portoroz, Slovenia, May 2007, <http://www.wseas.us/e-library/conferences/2007portoroz/papers/555-165.pdf> accessed 27.02.2018, p.82.
[43] European Commission, 'State aid N 475/2003 - Ireland Public Service Obligation in respect of new electricity generation capacity for security of supply' Brussels, 16.12.2003, C(2003)4488fin, para. 29 (hereinafter referred to as "Irish CADA Case") <http://ec.europa.eu/competition/state_aid/cases/137628/137628_485545_28_2.pdf> accessed 04.03.2018.
[44] *ibid.*, para 22.
[45] COIBON A. and PICKETT J., 'Capacity Mechanisms: Reigniting Europe`s Energy Markets', Linklaters LLP, 2014, <http://linklaters.de/fileadmin/redaktion/pdf/Linklaters%20Report_Capacity%20Markets.pdf> accessed 11.02.2016, p. 13.
[46] See, Recital 1 of the Security of Electricity Supply Directive, *Supra* note 29.

Article 1(1) of the same Directive specifies the adequate level of generation capacity as the key aim of this directive as well as an adequate balance between supply and demand and an appropriate level of interconnection among Member States.

It appears at the Security of Electricity Supply Directive foresees a market structure that contains both pro-market principles and government intervention to provide adequate and reliable power supply for final consumers.[47] Within this frame, in its Recital 10, it is stated that government measures taken to ensure adequate generation reserve capacity should be market-based and non-discriminatory and that these measures could involve contractual guarantees and arrangements, capacity options and obligations.[48] The said Directive in its Recital 5 further notes that when supporting renewable energy sources, availability of adequate back-up capacity, where technically necessary, should be ensured so as to maintain security of supply.[49] Additionally, pursuant to Article 5(1) of the said Directive, governments must take appropriate measures to sustain the balance between the power demand and availability of generation capacity.[50] Article 5(2) of the said Directive enables Member States to take additional measures provided that they must not contradict with Article 107 and 108 of the TFEU.[51] Especially Article 5(2)(f) allows Member States to introduce tendering procedures or any equivalent measures in the sense of transparency and non-discrimination in compliance with Article 8(1) of the Electricity Directive.[52] As mentioned above, the Commission itself interpreted these “tendering procedures and any equivalent measures” as strategic reserve, capacity payments, capacity requirements, reliability contracts, and capacity subscriptions in its own note.[53] So, it is clear that the Security of Supply Directive

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[47] HUHTA K. et al, ‘Legal and Policy Issues for Capacity Mechanisms in the Evolving European Internal Energy Market’, *European Energy and Environmental Law Review*, Volume 23, June 2014, p.78, pp.76-88.
[48] *See,* Recital 10 of the Security of Electricity Supply Directive, *Supra* note 29.
[49] *See,* Recital 5 of the Security of Electricity Supply Directive, *Supra* note 29.
[50] *See,* Article 5(1) of the Security of Electricity Supply Directive, *Supra* note 29.
[51] *See,* Article 5(2) of the Security of Electricity Supply Directive, *Supra* note 29.
[52] *ibid.* Article 5(2)(f) of the Security of Electricity Supply Directive refers to Article 7(1) of the Electricity Directive 2003 which is repealed by Article 8(1) of the Electricity Directive 2009.
[53] European Commission, ‘Note of DG Energy & Transport on Directives 2003/54/EC and 2003/55/EC on the Internal Market in Electricity and Natural Gas – Measures to Secure Electricity Supply’, *Supra* note 38.

permits Member States to establish CRMs in their jurisdictions as long as the necessary conditions are met.

The aforesaid legal framework obviously allows Member States to establish CRMs. However, in order to protect the IEM, the Commission might prevent Member States from creating unilateral CRMs by employing two legal tools: State Aid rules and the Free Movement of Goods.[54]

3.1.2 State Aid Rules

State Aid rules have always been an inseparable part of European competition policy since the adoption of the Treaty of Rome in 1957. The main aim of these rules is to maintain a level playing field for all market players in the internal market.[55] Under Articles 107 to 109, TFEU authorises the Commission to investigate State Aid that possibly distort competition and trade in the internal market. As a general principle, according to Article 107(1) of TFEU:

> "any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition by favouring certain undertakings or the production of certain goods shall, insofar as it affects trade between Member States, be incompatible with the internal market."

Under this provision, the Commission applies the following criteria while determining whether a measure constitutes a state Aid:[56]

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[54] Although the provisions on free movement and State aid are separate, it is obvious that both have a common objective: protecting the internal market to facilitate the free trade across borders under the normal conditions of competition. *See*, BIONDI A. and FARLEY M., `The Relationship between State Aid and the Single Market`, Chapter 12, in SZYSZCZAK E. (ed.), *Research Handbook on European State Aid Law*, Edward Elgar, Cheltenham 2011, pp. 277-278.

[55] European Commission, 'State Aid Action Plan: Less and better targeted state aid: a roadmap for state aid reform 2005-2009', Brussels, 07.06.2005, COM(2005) 107 final, <http://ec.europa.eu/competition/state_aid/reform/saap_en.pdf> accessed 27.02.2018, p.3.

[56] European Commission, 'Commission Notice on the notion of State aid as referred to in Article 107(1) of the Treaty on the Functioning of the European Union', (2016/C 262/01), OJ C262,

- the measure must confer an economic benefit to a beneficiary which could not have been obtained under normal market conditions, i.e. in the absence of state intervention;
- the beneficiary must be in the form of an undertaking engaging in an economic activity;
- the advantage must be granted to the beneficiary through direct or indirect State resources and be imputable to the State;
- the measure must be selective for granting an advantage to certain undertakings or certain sectors;
- the measure is liable to distort or threaten competition within the EU; and
- the measure has impact on trade between Member States.

A measure that cumulatively meets the above criteria shall be notified to the Commission by virtue of Article 108(3) of the TFEU. The Commission then evaluates the compatibility of the notified measure with the internal market. Articles 107(2) and 107(3) of TFEU set out a range of exceptions that make State Aid compatible with the internal market. Within the context of this research, Article 107(3) is relevant for CRMs.

As per Article 107(3)(c) of the Treaty, State Aid that is introduced to facilitate the development of certain economic activities within the EU is considered as compatible with the internal market as long as this aid does not adversely affect trading conditions to an extent contrary to the common interest.[57] The Commission assesses the compatibility of State Aid related to generation adequacy matters on the basis of the conditions indicated in Section 3.9 of EEAG (*See*, below, subheading: *3.1.2.1.1 Rise of the State Aid Rules as a Policy Tool in the Hands of the Commission*).

19.07.2016, pp.1-50 <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016XC0719(05)&from=EN> accessed 10.09.2017.

[57] European Commission, 'Communication from the Commission, Guidelines on State aid for environmental protection and energy 2014-2020', (2014/C 200/01), OJ C 200, 28.6.2014, pp.1-55 <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014XC0628(01)&from=EN> accessed 04.03.2018.

3.1.2.1 State Aid Rules within the Context of CRMs

CRMs involve open state interventions in electricity markets to ensure generation adequacy. These interventions have understandably carry some risks resulting in distorting market functions and thus competition in the IEM. Any state intervention to markets containing that kind of risk requires to be analysed in the context of EU State Aid Rules. Therefore, CRMs as a kind of state intervention in electricity markets will naturally be subject to these rules. The debate on the relationship between CRMs and the State Aid rules is actually not new. In 2003, the Commission handled the Irish Capacity and Differences Agreement (CADA)[58] by applying the well-known Altmark criteria.[59] According to the Altmark decision, the CJEU held that the discharge of a public service obligation is not assessed by Article 107(1) as long as it met four cumulative criteria. These criteria are as follow: 1- The recipient undertaking must actually have public service obligations and these obligations must be clearly defined; 2- The parameters on the basis of which the compensation is calculated must be established in advance in an objective and transparent way; 3- The compensation cannot exceed what is necessary to cover all or part of the costs incurred in the discharge of public service obligations, taking account the relevant receipts and a reasonable profit for discharging those obligations; and 4- Where the undertaking is not chosen through a public procurement procedure, the level of compensation provided must be determined by analysing the costs borne by a typical, well-run and adequately equipped undertaking to meet those obligations (hereinafter referred to as "Altmark critera").[60]

Within the context of this issue, the Irish Commission for Energy Regulation (CER) decided to establish a capacity payment mechanism called CADA to facilitate the entry of 531 MW of new capacity to the national market in order to prevent an important capacity shortfall from

[58] See, Irish CADA Case, *Supra* note 43.

[59] Altmark Case is a cornerstone case in many aspects. After this decision taken by the CJEU, the criteria outlined in this case have been strictly applied by the Commission to investigate whether a public service obligation is State aid free or not, *See* European Court of Justice, Judgement of 24.07.2003, Altmark Trans GmbH and Regierungspräsidium Magdeburg v Nahverkehrsgesellschaft Altmark GmbH, and Oberbundesanwalt beim Bundesverwaltungsgericht, Case C-280/00 (hereinafter referred to as "Altmark Case"). For further discussion, S*ee* KLASSE M., 'The Impact of Altmark: The European Commission Case Law Responses', Chapter 2 in SZYSZCZAK E. and VAN DE GRONDEN J. W. (Eds.), *Financing Services of General Economic Interest: Reform and Modernization,* T.M.C. Asser Press, The Netherlands, 2013.

[60] *See* Altmark Case, *Supra* note 59, para. 89-90-91-92-93.

2005 onwards foreseen by the TSO.[61] The CADA provided that generators receive payment based on their availability at most ten years and if the pool price exceeded the strike price defined in advance by the CADA in accordance with the short-run marginal cost of a new CCGT as the most efficient new entrants; generators must reimburse the difference between what they earned by selling the power at the pool price and what they would have earned when the Pool price would have been equal to the strike price.[62] Applying the four cumulative criteria of the Altmark case, the Commission rendered a verdict that the Irish capacity payments involved no State Aid within the meaning of Article 107(1) of the TFEU.[63] According to this decision, the CRM implemented in Ireland was accepted as a public service obligation that had not involved any State Aid.

3.1.2.1.1 Rise of the State Aid Rules as a Policy Tool in the Hands of the Commission

After the Irish CADA case, State Aid discussions concerning CRMs has flared up in recent years since new Member States started to establish their own mechanisms. As discussed above, on the one hand Member States have the right to develop new policies and incentive mechanisms in accordance with EU legislation to ensure the generation adequacy of their own countries. The commission, on the other hand, has the power to use State Aid Rules as a policy tool to keep member states in line. Therefore, it is of paramount importance to note that the Commission uses State Aid policy not only to enforce the prohibition of distortive State Aid, but also to encourage Member States to develop 'good' State Aid policies in their territories in line with the Commission's vision.[64] In principle, as stated by Blauberger, competences in the field of State Aid rules are unambiguously allocated between the Commission and Member States.[65] The Commission has exclusive competence to scrutinise the compatibility of State Aid with the internal market.[66] In contrast, and as indicated above, Member States have sovereignty to follow their own State Aid policies, as long as these do

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[61] *See*, Irish CADA Case, *Supra* note 43, para 4-5-6-7-8.
[62] *ibid,* para 9.
[63] *See*, Irish CADA Case, *Supra* note 43, para. 65.
[64] BLAUBERGER M., 'Of 'Good' and 'Bad' Subsidies: European State Aid Control through Soft and Hard Law' (2009) 32 *West European Politics,* Issue 4, p.719, pp.719-737.
[65] BLAUBERGER M., 'State aid control from a political science perspective', in SZYSZCZAK E. (ed.), *Research Handbook on European State Aid Law*, Edward Elgar, Cheltenham 2011, p. 33.
[66] NICOLAIDES P. et al, *State Aid Policy in the European Community: A Guide for Practitioners,* International Competition Law Series, Volume 16, Kluwer Law International, 2005, p. 9.

not disturb the internal market.[67] However, it is clear that the Commission does not confine itself to controlling State Aid in terms of its compatibility with the IEM. Rather, the Commission goes beyond this and tries to employ State Aid Rules as a policy instrument to harmonise State Aid policies implemented by Member States.[68] For CRMs, the Commission uses this power through the Guidelines on State Aid for Environmental Protection and Energy 2014-2020 (the Guidelines).[69] In Section 3.9 of the Guidelines, the Commission specified a set of conditions to assess the compatibility of CRMs with the IEM. These conditions are set out as follows:

- *Objective of common interest and need for state intervention:* According to Sections 3.9.1 and 3.9.2 of the Guidelines, CRMs must contribute to a well-defined objective of common interest and the need for state intervention should be properly identified. To do this, (1) a generation adequacy problem must be clearly defined consistent with the generation adequacy analysis conducted regularly by ENTSO-E; (2) alternative options to address the generation adequacy problem, such as facilitating demand-side participation and increasing interconnection capacity, must be primarily taken into account to avoid missing some other policy objectives such as phasing out environmentally or economically harmful State Aid; (3) the nature and causes of the generation adequacy problem, and thus the need for State intervention to guarantee generation adequacy, must be thoroughly analysed and quantified; (4) Member States must show why the market cannot be trusted to address the generation adequacy problem without State intervention, by taking into consideration ongoing market and technological developments.
- *Appropriateness:* As per Section 3.9.3 of the Guidelines, (1) CRMs must remunerate only the pure availability of capacity and must not include any compensation for the sale of electricity; (2) furthermore, CRMs must be open to all relevant capacity providers

[67] BLAUBERGER M., 'State aid control from a political science perspective', *Supra* note 65, p. 33.
[68] Sadowska made an interesting discussion regarding how the Commission employs competition rules to reach some regulatory aims, especially in industries that need sector-specific regulation. *See*, SADOWSKA M., 'Committed to reform? Pragmatic antitrust enforcement in electricity markets', PhD Thesis, <http://amsdottorato.unibo.it/5256/1/sadowska_malgorzata_tesi.pdf> accessed 20.10.2015.
[69] European Commission, 'Communication from the Commission, Guidelines on State aid for environmental protection and energy 2014-2020', *Supra* note 57.

including existing and new generators, demand side participation, and storage technologies, by taking account of different lead times of capacity investments and the contribution of interconnection capacity.

- *Incentive effect:* CRMs must have an incentive effect compatible with the IEM, as required by Section 3.9.4 of the Guidelines. Section 3.2.4 of the Guidelines defines incentive effect as an inducement to change the behaviour of the beneficiary to improve the functioning of the IEM. This is a change in behaviour that would not happen in the absence of CRMs.
- *Proportionality:* According to Section 3.9.5 of the Guidelines, the overall amount of aid granted by CRMs must be proportional. The Guidelines define *proportionality* as "the aid amount […] limited to the minimum needed to incentivise the additional investment or activity in the area concerned."[70] Within this scope, (1) the amount of the aid must provide beneficiaries with a reasonable rate of return, which is assumed to be achieved through a competitive bidding process based upon clear, transparent, and non-discriminatory criteria; (2) CRMs must have built-in mechanisms to prevent windfall profits.
- *Avoidance of negative impact on competition and trade:* Section 3.9.6 of the Guidelines obliges Member States to design CRMs in such a way that any capacity resources including interconnected capacity, as long as it is effectively contributing to ensure generation adequacy, can participate in CRMs.

It would not be inaccurate to say that the Commission does not only control whether national CRMs are compatible with State Aid rules through the criteria mentioned above, but also guides Member States to develop their CRMs in line with its own vision. On this issue, Huhta *et al* state that "the guidelines restrict the Member States' room to manoeuvre by expressing a strong preference for the adoption of competitive bidding processes, a technology-neutral design of capacity mechanisms and by requiring them to be open for operators from other Member States."[71] By doing so, the Commission aims to force Member States to meet minimum requirements to protect the IEM. This situation has become more apparent with State Aid decisions of the Commission regarding Member States CRMs analysed below. It should also be critically noted that the State Aid decisions examined below are discussed in

[70] *ibid*, p.11.
[71] HUHTA K. et al, 'Legal and Policy Issues for Capacity Mechanisms in the Evolving European Internal Energy Market', *Supra* note 47, p.88.

detail. By examining these Cases, the aim is to show how the Commission makes State Aid decisions concerning CRMs in Member States so as to force Member States to open their CRMs to foreign capacity resources.

UK - Capacity Market – Case Number SA.35890

As in other European countries, liberalisation of the UK electricity market led to challenges for ensuring generation.[72] According to an estimation made by the UK authorities, the generation adequacy level of Great Britain will be at a critically low level in 2017-2018.[73] Therefore, on the basis of the Energy Act 2013, the UK established its centralised forward capacity market which takes into account existing and new generators, demand side response and storage technologies.[74] The Commission's first decision concerning State Aid in the context of CRMs under the abovementioned principles of the Guidelines was about the UK Capacity Market. Another feature of this decision is that it is the first and only clearance of the Commission before the start of the State Aid Sector Inquiry for CRMs. The Commission's decision is quite crucial. The reason for this is that the UK Capacity Market, as a forward capacity market, is the most interventionist type of CRM compared to others. Therefore, it can be expected that the Commission may adopt a positive approach for other less interventionist CRMs, provided that they meet the criteria outlined by the Guidelines.

The Commission, in its first decision given in accordance with the new Guidelines, gave clearance to the UK Capacity Market under the commitment that:

> "the UK will enable interconnected capacity to participate in the Capacity Market ahead of the second auction in 2015. New interconnectors, in particular, will have access to the auctions which should be non-discriminatory and provide

[72] European Commission, 'State aid: Commission authorises UK Capacity Market electricity generation scheme, at', Press Release, 23.07.2014, <http://europa.eu/rapid/press-release_IP-14-865_en.htm> accessed 29.09.2014.
[73] *Ibid*.
[74] *ibid*, para 4.

> new interconnectors with adequate incentives, for example taking into account different lead times."[75]

Indeed, the UK developed an interim solution named "Interconnector-led Approach" to enable foreign capacity resources to participate in capacity auctions held in the UK in line with its commitment. This issue is briefly mentioned below under the Subheading of 4.3 Allocation of Interconnectors' Capacity.

This case was vital, since it gave the first clue regarding how the Commission interpreted the Guidelines when assessing CRMs. Further, this decision was an initial signal that showed how the Commission employed the Guidelines as a policy tool to force Member States to design their CRMs in accordance with the intentions of the Commission.

FRANCE - Country Wide Capacity Mechanism – Case Number: SA.39621

Pursuant to the NOME Act 2010, electricity suppliers, network operators (for losses) and consumers have to contribute to ensure generation adequacy in France in accordance with their own and their customers' electricity consumption.[76] In order to meet this commitment, each of these market players must verify that they have a firm volume of capacity guarantees with regard to their own and their customers' peak-period consumption.[77] With this understanding, the French CRM, being in the form of a national market-wide capacity mechanism as a form of capacity obligation, was established with the aim of ensuring efficient capacity for electricity generation in order to meet demand, in particular during extreme demand peaks. It was planned to be implemented as of 2017 and the first auction took place in late December 2016.[78]

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[75] European Commission, 'State aid SA.35980 (2014/N-2) – United Kingdom Electricity market reform – Capacity market', Brussels, 23.7.2014, C (2014) 5083 final, <http://ec.europa.eu/competition/state_aid/cases/253240/253240_1579271_165_2.pdf> accessed 04.03.2018, para. 95.

[76] European Commission, 'Commission Decision of 8.11.2016 on state aid scheme SA.39621 2015/C (ex 2015/NN)' (Text with EEA relevance) Brussels, 8.11.2016, C (2016) 7086 final, <http://ec.europa.eu/competition/state_aid/cases/261326/261326_1873332_314_5.pdf>, accessed 11.09.2017.

[77] *ibid*, para. 7.

[78] For more information on the CRMs in France, *see* Table 9 CRMs in the EU Member States' in Chapter 3 above.

At this juncture, it should be noted that the French authorities did not notify the Commission regarding the French CRM. The reason for this is that the French authorities supposed that the French CRM constituted a public service obligation in line with the Altmark Criteria; therefore, according to them, they can avoid notification responsibility. As discussed above within the context of the Irish CADA case, CRMs do not inevitably involve State Aid, they may also be qualified as a public service obligation. In that case, according to the Commission Decision,[79] Member States can avoid from notification obligation to the Commission required by Article 108(3) of the TFEU. According to a Commission Guide:[80]

> "[w]here all the Altmark criteria are met, the public service compensation does not constitute state aid. Where at least one of the Altmark criteria is not met, but the other State aid criteria are fulfilled, the public service compensation constitutes State aid. However, it may still be compatible with Article 106 TFEU and exempted from notification under the Decision […]"

However, the Commission did not accept the French arguments and initiated a unilateral State Aid investigation within the scope of the State Aid Inquiry for CRMs. The Commission explained its concerns regarding the French CRMs, that it would favour certain companies over their competitors and restrict new market payers from entering into the French

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[79] European Commission, 'Commission Decision of 20 December 2011 on the application of Article 106(2) of the Treaty on the Functioning of the European Union to State aid in the form of public service compensation granted to certain undertakings entrusted with the operation of services of general economic interest (notified under document C(2011) 9380) Text with EEA relevance', OJ L 7, 11.1.2012, p. 3–10 <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012D0021&from=EN> accessed 04.03.2018, para. 7. This Decision of the Commission repealed the Commission Decision of 28 November 2005 on the application of Article 86(2) of the EC Treaty to State aid in the form of public service compensation granted to certain undertakings entrusted with the operation of services of general economic interest (notified under document number C(2005) 2673) OJ L 312, 29.11.2005, p. 67–73.

[80] European Commission, 'Commission Staff Working Document: Guide to the application of the European Union Rules on state aid, public procurement and the internal market to services of general economic interest, and in particular to social services of general interest', SWD(2013) 53 final/2, Brussels, 29.04.2013, <http://ec.europa.eu/competition/state_aid/overview/new_guide_eu_rules_procurement_en.pdf> accessed 27.02.2018, p.51.

electricity market.[81] Consequently, the Commission announced in its Press Release dated 13th of November, 2015 saying it had started an investigation to find out whether the envisaged French CRM was in line with EU State Aid Rules and compatible with the Internal Market.[82] The Commission, in its final decision dated 18.11.2016, expressed that France unlawfully implemented the CRM in infringement of Article 108(3) TFEU. However, at the end of the day, the Commission approved the French CRM after France proposed different remedies for the design of its capacity obligations.[83] One of these remedies, as can be expected, is to open the doors of the French CRM to foreign capacity resources. At first, the Commission objected to the design of the French CRM since it excluded foreign capacity resources.[84] After this objection, France proposed a "hybrid approach" to enable foreign capacity resources to participate in the CRM held in France. This model works as follow: (1) Foreign capacity resources who want to participate in the French CRM must first of all acquire interconnection tickets to be able to become certified. Interconnection tickets are distributed 'interconnector by interconnector' on the basis of each interconnectors' contribution to generation adequacy in France; and (2) Once foreign capacity resources acquire their tickets, they can be part of the French CRM in line with the capacity of their interconnection tickets.[85]

FRANCE – Tender for additional capacity in Brittany – Case Number: SA.40454

In parallel to the French CRM, a tender scheme was initiated for overcoming security of supply concerns and providing additional capacity in Landivisiau, Brittany, a region which is poorly connected with the rest of France. [86] Within this context, Compagnie Electrique de Bretagne (CEB) won the tender for the construction of the Landivisiau gas-fired power plant (combined cycle gas turbine).[87]

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[81] European Commission, 'State aid: Commission opens in-depth investigations into French plans to remunerate electricity capacity', Press Release, 13.11.2015, <http://europa.eu/rapid/press-release_IP-15-6077_en.htm> accessed 11.09.2017.
[82] *ibid*.
[83] European Commission, 'Commission Decision of 8.11.2016 on state aid scheme SA.39621 2015/C (ex 2015/NN)', *Supra* note 76, para. 303.
[84] *ibid*, para. 64.
[85] *İbid*, para. 119-124.
[86] European Commission, 'State aid: Commission opens in-depth investigations into French plans to remunerate electricity capacity', *Supra* note 81.
[87] *Ibid*.

The Commission opened an investigation based on its concerns that the aid was granted to only one type of technology and was closed to other potential types of generation, demand side management, network extensions or storage solutions and consequently opened an investigation.[88] The Commission found the measure proportionate, necessary and in line with State Aid rules and in particular with the EEAG; however, the Commission approved the subsidy given to CEB subject to the condition that CEB will not sell electricity from the Landivisiau power plant with long-term contracts to any company with a share of over 40% of the French electricity-generation capacity market.[89]

GERMANY – The ABLAV Interruptibility scheme – Case Number: SA.43735

Within the context of comprehensive electricity market reform in Germany, among other policy developments, the Government proposed an interruptibility scheme named the ABLAV in order to incentive electricity consumers, where they are enabled through installing necessary equipment, to amend their consumption behaviours in accordance with price signals.[90] The German electricity market, as discussed in Chapter 3, has an increasing share of intermittent renewable energy in the generation mix and thus requires increasing flexibility in the electricity grid.[91] In line with this necessity, the ABLAV scheme to be implemented in Germany is defined as an interruptibility scheme permitting German TSOs to execute contracts with medium and large consumers up to 1,500 MW. [92] Customers are required to be medium-sized and large companies, consuming more than 10 MW and selected by the TSOs by means of weekly online auctions.[93] Consequently, the measure is considered as enabling TSOs to stabilise the electricity network by minimising demand when required.[94]

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[88] *Ibid*.
[89] *Ibid*.
[90] European Commission, 'State aid No. SA.43735 (2016/N) – Germany ABLAV Interruptibility Scheme', Final Decision, 24.10.2016, <http://ec.europa.eu/competition/state_aid/cases/264060/264060_1841480_86_2.pdf>, accessed 13.09.2017.
[91] European Commission, 'State aid: Commission approves German electricity demand response scheme', Press Release, 24.10.2016, <http://europa.eu/rapid/press-release_IP-16-3524_en.htm> accessed 13.09.2017.
[92] European Commission, 'State aid No. SA.43735 (2016/N) – Germany ABLAV Interruptibility Scheme', Final Decision, *Supra* note 90.
[93] *Ibid*.
[94] European Commission, 'State aid: Commission approves German electricity demand response scheme', *Supra* note 91.

In consequence of its assessment, the Commission considered that the ABLAV scheme aimed at assuring the reliability of the short term electricity system and at making available capacity contributing to generation adequacy in the long term.[95] Therefore, the measure was regarded to be a security of electricity supply measure and a CRM falling within the context of Section 3.9 of the EEAG on State Aid for generation adequacy.[96] The ABLAV scheme was also considered to be a CRM where capacity is provided by the demand side.[97]

On this basis, the Commission also assessed whether the ABLAV scheme was compatible with the internal market pursuant to Article 107(3)(c) TFEU, and if it met the criteria on CRMs listed in Sections 3.9.1 to 3.9.7 of the EEAG. In conclusion, the Commission stated that the scheme could help to develop both short-term and long-term reliability in line with EU State Aid rules.[98]

GERMANY – Network Reserve – Case Number: SA.42955

On 4th of July 2016, Germany notified the Commission that it had introduced revisions with regards to the existing Network Reserve.[99] Under this measure, German TSOs make a payment to power plants located in Southern Germany, which are either not operated or notified to be temporarily or permanently closed down, but are necessary to keep the electricity system in balance.[100] This measure enabled TSOs to activate power plants contributing in the Network Reserve, when transmission capacity is inadequate to transport electricity from generation facilities located in the North to meet demand in the Southern Germany.[101] Power plants operating in the neighbouring countries, in particular the Austrian and Italian electricity markets, can be also contracted by way of organising a call for

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[95] European Commission, 'State aid No. SA.43735 (2016/N) – Germany ABLAV Interruptibility Scheme', *Supra* note 90, p.12
[96] *Ibid*.
[97] *Ibid*, p. 11, para.55.
[98] *Ibid*, p. 20, para.104.
[99] European Commission, 'State aid No. SA.42955 (2016/N-2) – Germany Network Reserve', Final Decision, 20.12.2016, <http://ec.europa.eu/competition/state_aid/cases/265043/265043_1872192_91_2.pdf>, accessed 13.09.2017.
[100] *Ibid*., p.3
[101] *Ibid*, p.3

expressions of interest, if the capacity supplied by those power plants are not sufficient to meet the necessary need.[102] In such cases, German TSOs may require foreign generators to increase or decrease generation to keep the grid in balance.[103]

In the light of its assessment, the Commission considered that the Network Reserve constituted State Aid within the meaning of Article 107(1) TFEU. It also found that the measure aimed at ensuring generation adequacy and security of electricity supply and as such it is a CRM in the type of strategic reserve.[104]

Concerning the assessment of the appropriateness of the measure, Germany committed that the Network Reserve will be implemented as a transitional measure and be accompanied by measures that address the cause of the adequacy problem (e.g. market reforms), as underlined in the Commission's Final Report on the sector inquiry on capacity mechanisms published on 30 November 2016.[105] Consequently, the Commission found it compatible with the internal market in accordance with Article 107(3)(c) TFEU and by considering the Network Reserve as a transitional measure, approved the measure only up to and including the winter of 2019/2020, i.e. until 30 June 2020.[106]

GERMANY – German Capacity Reserve – Case Number: SA.45852

In January 2017, Germany notified the Commission of its draft legislation related to the Capacity Reserve as well as an assessment of the necessity of the measure. Having examined the explanations of Germany, the Commission expressed its concerns that the measure may distort competition and favour power plant operators over demand response operators and hence opened an investigation to evaluate whether the planned Capacity Reserve complies with the EU state ait rules.[107]

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[102] *Ibid*, p.25.
[103] European Commission, 'State aid: Commission clears German Network Reserve for ensuring security of electricity supply', Press Release, 20.12.2016, <http://europa.eu/rapid/press-release_IP-16-4472_en.htm>, accessed 13.09.2017.
[104] Ibid, p.9-10.
[105] *Ibid*, p.16, para.75.
[106] *Ibid*, p.26, para.128.
[107] European Commission, 'State aid: Commission opens in-depth investigation into German plans for electricity capacity reserve', Press Release, 07.04.2017, <http://europa.eu/rapid/press-release_IP-17-903_en.htm> accessed 13.09.2017. The Commission recently approved German Capacity Reserve

Germany has introduced the Capacity Reserve, alongside of the Network Reserve and the ABLAV scheme examined above, as a measure being part of the market reforms aiming at ensuring security of electricity supply under the changing circumstances in the electricity market.[108] Under the measure, the four German TSOs will progressively develop reserve capacity of 2GW outside the market in order to ensure security of supply in cases where the wholesale market does not succeed to provide sufficient supplies to meet all need.[109]

GREECE – Transitory Electricity Flexibility Remuneration Mechanism (FRM) – Case Number: SA.38968

In the Greek Electricity Market, the share of intermittent RESs including wind and solar power plants in the generation mix has increased in recent years.[110] It is expected that this trend will intensify since Greece aims to meet the 2020 RES targets in keeping with the EU Renewable Directive.[111] Thus, the challenges for ensuring generation adequacy, especially during evening hours because of the so-called "sunset effect", has become visible.[112] With the objective of providing efficient flexibility services and minimising the risk of plants that are providing those services to be closed or mothballed, the transitory electricity flexibility remuneration mechanism has been implemented in Greece from 2015 onwards.[113] Accordingly, certain generators are remunerated for the provision of 'flexibility services' to the Greek TSO, ADMIE. The mechanism works as follow: "[O]n instruction from the TSO and subject to a specified notice period, beneficiaries increase or decrease the amount of

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as well as other five CRMs in Belgium (Strategic Reserve), Italy (Reliability Options), Poland (Capacity Market), France (Demand response scheme) and Greece (Interruptibility scheme). *See* European Commission, 'State aid: Commission approves six electricity capacity mechanisms to ensure security of supply in Belgium, France, Germany, Greece, Italy and Poland – Factsheet', 07.02.2018, <http://europa.eu/rapid/press-release_MEMO-18-681_en.htm> accessed 03.03.2018.

[108] European Commission, 'State Aid SA.45852 (2017/N) – Germany Capacity Reserve', Opening Decision, 07.04.2017, <http://ec.europa.eu/competition/state_aid/cases/269083/269083_1890897_10_2.pdf>, accessed 13.09.2017, p.2.

[109] *Ibid*, p.3.

[110] European Commission, 'State aid n° SA.38968 (2015/N) Greece Transitory Electricity flexibility remuneration mechanism (FRM)', Final Decision, 31.03.2016, <http://ec.europa.eu/competition/state_aid/cases/256426/256426_1751668_182_2.pdf> accessed 12.09.2017, p.1 and p.17.

[111] *ibid*.

[112] *İbid*.

[113] *ibid*.

electricity injected into the electricity system at a specified minimum rate on a multi-hour time-scale."[114]

In light of its assessment, the Commission considered that the measure constituted State Aid within the meaning of Article 107(1) TFEU and is compatible with Section 3.9 of the EEAG which set out the conditions for aid to generation adequacy. Accordingly, the Commission found that the measure contributed to an objective of common interest and was necessary in accordance with Section 3.9.1 and 3.9.2 of the EEAG, met the conditions stipulated under Section 3.9.3 of the EEAG for being appropriate, had an incentive effect as required by Section 3.9.4 of the EEAG, met the conditions regulated under Section 3.9.5 of the EEAG for being proportionate and did not result in undue distortion of competition and trade, and thus was compatible with Section 3.9.6 of the EEAG.[115] In addition, the Commission also found the measure in compatible with Article 30 and 110 TFEU (108).

The Commission approved the Greek CRM although it did not include any provision concerning cross-border participation. The reason for this is that the Commission found the Greek authorities reasons for not permitting foreign resources to participate in the Greek CRM. These excuses are listed in Paragraph (36) and (37) of the Case; that is, flexibility services can only currently be provided by means of domestic capacity since (1) there is insufficient coordination among TSOs in the South East European Region; (2) electricity markets in this region are not operationally coupled and hence interconnectors' capacities are not allocated on a flow-basis; (3) the capacity of interconnectors are systematically close to congestion; (4) the interconnector with Italy has been disconnected; and (5) because the current electricity import in Greece is mainly based on long term contracts, electricity importers submit enormously low bids in the pool so as to guarantee their inclusion in the merit order.[116] Because of these reasons, foreign capacity resources are not eligible in the Greek CRM. However, the Commission stated that:

[114] *ibid*, p. 3.
[115] *Ibid*, p.18 and p.20.
[116] *ibid*.

> "[T]he contribution of interconnected capacity has been considered in the necessity assessment. Further, the Hellenic Republic commits to opening the planned permanent capacity mechanism to the participation of cross-border resources with neighbouring systems. To this end, the Greek competent authorities have committed to immediately initiating discussions with the Italian authorities and other European organizations, such as ENTSO-E."[117]

3.1.3 Free Movement of Goods

Articles 34 and 35 of TFEU prohibit quantitative restrictions on imports and exports and all other measures having equivalent effect. Hence, according to these provisions, Member States must not exclude foreign capacity resources from their CRMs. Furthermore, Article 30 of TFEU prohibits the imposition of customs duties on exports and imports and other charges that have equivalent effect on trade between Member States. In this regard, imposing any charges on capacity imports or exports which may detrimentally affect trade between Member States is forbidden by Article 30 of TFEU. Therefore, it could be argued that rules on the Free Movement of Goods can be employed by the Commission to prevent Member States to design their CRMs with a unilateral approach.

3.2 Economic Justifications

3.2.1 The Benefit of National Differences: Reduction of the Generation Adequacy Costs

The energy market structures of Member States vary considerably in terms of reserve margins, stress events and generation mixes. This diversity offers a great opportunity for Europe to maintain generation adequacy with lower costs. To begin with, according to the Adequacy Forecast of ENTSO-E, it seems that there are, and there will be, substantial

[117] *İbid*, para. 80.

differences among the European countries' reserve margins throughout the next decade.[118] While some countries enjoy a high level of surplus capacities, others suffer from declining reserve margins. Countries that expect capacity shortage in the near future might benefit from the aforesaid surplus capacities, provided that CRMs allow cross-border participation.[119] Secondly, stress events in European energy markets do not happen simultaneously at all times, which means that surplus capacities will not commonly be required synchronously by different countries.[120] For instance, according to research conducted by Pöyry, while the majority of low reserve margins appeared during winter in France and the UK between 2005 and 2012, the chance of their occurrence on the same day was very low.[121] The findings of ENTSO-E on this issue also support this argument. The regional analysis part of the ENTSO-E report indicates that even though some countries including Denmark, Germany, the Czech Republic, and Switzerland may need simultaneous imports in some scenarios during winter-time, there will be ample capacity from neighbour countries to support these markets.[122]

Finally, there is substantial diversity among Member States in terms of generation mixes.[123] While some countries such as Germany, Denmark, Spain, and Italy are rich in wind and solar power, others including the UK, Poland, the Netherlands, Belgium, and France have considerable fossil-fuel generators and nuclear resources.[124] Additionally, Norway, Switzerland, and Austria enjoy massive hydro capacity.[125] It is clear that this diversity in generation mix can be seen as a strong factor enhancing solidarity among the European countries to ensure generation adequacy.

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[118] ENTSO-E, 'Scenario Outlook and Adequacy Forecast 2014-2030', <https://www.entsoe.eu/Documents/SDC%20documents/SOAF/141031_SOAF%202014-2030_.pdf> accessed 30.05.2015, pp. 77-86.
[119] BARITAUD M. and VOLK D., 'Seamless Power Markets: Regional Integration of Electricity Markets in IEA Member Countries', *Supra* note 22, p. 70.
[120] HENRIOT A. and GLACHANT J. M., 'Capacity Mechanisms in the European Market: Now, but How?', *Supra* note 20, p.3.
[121] SHAKOOR A. and WILKS M., 'Analysis of the Correlation of Stress Periods in the Electricity Markets in GB and its Interconnected Systems', A Report to Ofgem, Pöyry 2013, <https://www.ofgem.gov.uk/ofgem-publications/75231/poyry-analysis-correlation-tight-periods-electricity-markets-gb-and-its-interconnected-systems.pdf> accessed 02.06.2015, p.3.
[122] ENTSO-E, 'Scenario Outlook and Adequacy Forecast 2014-2030', *Supra* note 118, p. 86.
[123] BARITAUD M. and VOLK D., 'Seamless Power Markets: Regional Integration of Electricity Markets in IEA Member Countries', *Supra* note 22, p.17.
[124] *ibid*.
[125] *ibid.*

3.2.2 Distortive Effects of Unilateral CRMs

CRMs, whether strategic reserves or other market-wide options such as capacity markets, capacity obligations and reliability options, have several cross-border impacts. This is one of the hardest challenges to solve or minimise, especially in highly interconnected electricity markets. As there is a continuing process concerning the integration of the EU electricity markets, the Commission has insistently expressed its concerns regarding the negative cross-border implications of capacity mechanisms in a range of official documents since the debate regarding capacity mechanisms flared up in Europe.[126] In addition to these, other European institutions such as ACER note the potential cross-border implications of CRMs.[127]

A number of theoretical studies as well as some real-life cases show that the Commission and other institutions such as ACER are not wrong in their concerns. Tennbakk, for instance, comprehensively analysed the adverse effects of unilateral CRMs within the IEM.[128] According to Tennbakk, if CRMs are unilaterally implemented:

> "the value of interconnectors and trade is affected and typically reduced. Generally we might say that if interconnector capacity is not taken into account the implementation of capacity mechanisms separates the long

[126] For instance, *See,* European Commission, 'Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Making the Internal Energy Market Work', *Supra* note 3, p.15; European Commission, 'Consultation Paper on Generation Adequacy, Capacity Mechanisms and the Internal Market in Electricity', 15.11.2012, <https://ec.europa.eu/energy/sites/ener/files/documents/20130207_generation_adequacy_consultation_document.pdf> accessed 27.02.2018, p.9-10; and European Commission, 'Communication from the Commission: Delivering the Internal Electricity Market and Making the Most of Public Intervention', *Supra* note 4, p.8.

[127] ACER, 'Report on Capacity Remuneration Mechanisms and the Internal Market for Electricity', *Supra* note 15, pp.10-17.

[128] TENNBAKK B., 'Capacity Mechanisms in Individual Markets within the IEM', THEMA Consulting Group, 28.05.2013, <https://ec.europa.eu/energy/sites/ener/files/documents/20130207_generation_adequacy_study.pdf>, accessed 27.02.2018, p. 48-62.

term development of the markets and reduces the value of market integration."[129]

Cepeda and Finon,[130] in their stimulating paper, tested several hypothetical cases to investigate how different generation adequacy policies may interact in interdependent electricity markets. In this study, relative to a benchmark model with two interdependent energy-only markets, comparisons were made among different markets where price-capping and/or CRMs have been introduced. They concluded that "in a regional electricity market, the lack of harmonization in price capping and capacity mechanisms across interconnected capacity power markets may lead to undesirable side effects by distorting their normal functioning."[131] Meyer and Gore[132] also argued that CRMs may have four spillover effects including price effects, capacity effects, welfare effects and effects on infrastructure investment. According to Meyer and Gore, "policy makers in the connected markets should act simultaneously in changing their market design to avoid temporary negative effects of a unilateral implementation."[133] In another study, Özdemir *et al*.[134] simulated the impact of the unilateral implementation of a national CRM in Germany (Northwest Europe). Özdemir *et al* also put forward that the impact of national CRMs implemented unilaterally exceeded national borders and affected the functions of the IEM since once unilateral CRMs are introduced, level playing field among European generators will disappear.[135]

In addition to these theoretical studies, the Russian CRM provides an interesting real-life case to illustrate how the unilateral implementation of CRMs affect cross-border power trade. Major reforms were introduced in the Russian electricity market in 2011, included the

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[129] *ibid*, p.57.
[130] CEPEDA M. and FINON D., 'Generation capacity adequacy in interdependent electricity markets', 39 *Energy Policy* (2011), pp.3128-3143.
[131] *ibid*., p. 3140
[132] MEYER R. and GORE O., 'Cross-Border Effects of Capacity Mechanisms: Do Uncoordinated Market Design Policies Countervail the Goals of European Market Integration', Bremen Energy Working Papers No.17, Jacobs University, Bremen, June 2014, <https://www.econstor.eu/bitstream/10419/103348/1/800137191.pdf> accessed 27.02.2018, p.3.
[133] *ibid*.
[134] ÖZDEMİR Ö. *et al*., 'Discussion Paper: Generation Capacity Investments and High Levels of Renewables: The Impact of a German Capacity Market on Northwest Europe', May 2013, <www.ecn.nl/docs/library/report/2013/e13030.pdf> accessed 21.09.2014.
[135] *ibid*., p. 29.

implementation of a forward capacity market to attract new generation investment in Russia.[136] However, following implementation, power export from Russia to Finland declined considerably.[137] According to the Sweco report, the utilisation of interconnections between Russia and Finland decreased sharply from 90% in 2010 to 35% in 2012.[138] The reason behind these reductions was that CRM participants in Russia are incentivised to reduce their exports during certain times.[139] This is made to avoid the free-riding problem. The Russian-Finnish case is a very remarkable example to comprehend the potential impact of CRMs in electricity trading among interconnected markets. Furthermore, capacity payment mechanisms implemented in the single market between Ireland and Northern Ireland can be shown as another real-life case illustrating this issue. According to the Consultation Paper, this mechanism "has created difficulties in cross-border trade with Great Britain with a capacity charge being imposed on exports and capacity uplift provided to imports to compensate for the effect of the payment on market prices."[140]

Furthermore, the impact of CRMs in international electricity trade and investments may change depending on the level of market integration, the design of CRMs and the correlation of scarcity conditions.[141] In its comprehensive work, ACER divided the cross-border implications of CRMs into two groups as short-term and long-term effects.[142] According to ACER, CRMs may affect prices and therefore cross-border competition in the short-term. Unilateral CRMs inevitably impact cross-border trade and competition, since the uncoordinated implementation of CRMs has direct effects on prices and dispatch decisions of

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[136] COIBON A. and PICKETT J., 'Capacity Mechanisms: Reigniting Europe`s Energy Markets', *Supra* note 45, p. 25.
[137] *ibid.*
[138] SWECO, 'Capacity Markets in Europe: Impacts on Trade and Investments', *Supra* note 24, p.34.
[139] COIBON A. and PICKETT J., 'Capacity Mechanisms: Reigniting Europe`s Energy Markets', *Supra* note 45, p. 25.
[140] *See*, European Commission, 'Consultation Paper on Generation Adequacy, Capacity Mechanisms and the Internal Market in Electricity', *Supra* note 126, p.9.
[141] VILJAINEN S. et al, 'Analysis of capacity remuneration mechanisms (CRMs) in Europe from the perspective of the internal European market for electricity', Elforsk Report 14:22, <http://www.elforsk.se/Programomraden/Anvandning/MarketDesign/Projects/Projects-2010---2013/14-Analysis-of-capacity-remuneration-mechanisms-CRMs-in-Europe-from-the-perspective-of-the-internal-European-market-for-electricity-/>, accessed 27.02.2018, p.5
[142] ACER, 'Report on Capacity Remuneration Mechanisms and the Internal Market for Electricity', *Supra* note 15, p. 10.

generators.[143] As mentioned above, this effect has been observed between Russia and Finland since the Russian capacity market rules for cross-border trade were put in place in 2011. After this date, cross-border energy flow from Russia to Finland sharply decreased to one-third throughout the peak-time periods as a result of an extra fee put on electricity flows from Russia to Finland.[144] In the long term, CRMs may influence investment decisions in terms of plant type choices and locations. On the one hand, this distortion is likely to cause over-capacity in countries with CRMs, due to an overestimation of domestic capacity needs and underestimation of the cross-border contribution, which may have a detrimental impact on consumers.[145] On the other hand, the negative influence of unilateral CRMs may expand to adjacent countries with or without CRMs by reducing investments in their markets.[146] Tennbakk also pointed out the distorting effect of capacity mechanisms over the allocation of investment decisions.[147]

In light of the foregoing discussions, tackling generation adequacy with a multinational approach rather than a self-sufficiency approach will enable efficient distribution of resources, which will definitely reduce the general cost of generation capacity. As per the study conducted by Booz & Co., if generation adequacy policies were harmonised across borders, the total cost savings would be €3 to €7.5 billion per year by 2030.[148] To alleviate, if not remove, these distortive effects of the unilateral CRMs analysed above, a range of regulatory arrangements should be put in place to integrate CRMs across borders.

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[143] CALDECOTT B. and MCDANIELS J., 'Stranded generation assets: Implications for European capacity mechanisms, energy markets and climate policy', *Supra* note 9, p.34.
[144] ACER, 'Report on Capacity Remuneration Mechanisms and the Internal Market for Electricity', *Supra* note 15, pp. 27-29.
[145] TENNBAKK B., 'Capacity Mechanisms in Individual Markets within the IEM', *Supra* note 128, p.2.
[146] ACER, 'Report on Capacity Remuneration Mechanisms and the Internal Market for Electricity', *Supra* note 15, p. 13.
[147] *See*, TENNBAKK B., 'Capacity Mechanisms in Individual Markets within the IEM', *Supra* note 128, p.2.
[148] See, NEWBERY D. et al, 'Benefits of an integrated European Energy Market', Prepared for the Directorate-General Energy of the European Commission, 20.07.2013, <https://ec.europa.eu/energy/sites/ener/files/documents/20130902_energy_integration_benefits.pdf> accessed 03.06.2015, p.89. Furthermore, the other research puts forward that the welfare loss of excluding interconnectors from CRMs might be as high as €2.6 billion until 2020, See, FRONTIER ECONOMICS, 'Interconnector participation in Capacity Remuneration Mechanisms: A Report Prepared for Energy Norway', January 2014, <https://www.frontier-economics.com/documents/2014/05/frontier-report-interconnector-participation-in-capacity-remuneration-mechanisms.pdf> accessed 03.06.2015, p.51.

4. Harmonised Regulatory Framework for Integration: Minimum Requirements for Capacity Trading Across Borders

All the justification discussions presented above make it clear that the integration of CRMs in the EU should be a priority This is a necessity from both the legal and the economic perspectives. Nevertheless, it should be understood that this is not a target without challenges including certification of firm capacity, delivery of capacity, concurrent scarcity problems, monitoring, and validity of delivery of capacity.[149] These challenges should be overcome to make foreign capacity resources as reliable as domestic capacity resources for national CRMs. This issue has been intensively discussed by all relevant actors from the Commission to Member States in recent years; however, no MS that has established or is contemplating establishment of a CRM in its jurisdictions has yet provided any solid solution to ensure explicit cross-border participation. This fact underlines the complexity of challenges. Even so, this should not prevent researchers from attempting to propose general principles to create a regulatory framework enabling explicit cross-border participation in Europe.

A regulatory framework should be developed to provide some minimum requirements to enable capacity trading across borders by eliminating the challenges indicated above. Several measures can be taken at the EU, regional and national levels to provide minimum requirements for capacity trading across borders. These measures can be put in order as Harmonised Generation Adequacy Assessments, Respecting Contracted Capacity Obligations, Allocation of Interconnectors' Capacity, and No Double Counting.

4.1 Harmonised Generation Adequacy Assessments

As indicated several times throughout this study, interconnected capacity is crucial for meeting the generation adequacy needs of Member States. However, a report prepared by the Council of European Energy Regulators (CEER) revealed that generation adequacy assessments in European countries are still made without taking into account interconnected

[149] MENNEL T. et al, 'Potential Interactions between Capacity Mechanisms in France and Germany: Descriptive Overview, Cross-border Impacts and Challenges', March 2015, <https://www.stiftung-mercator.de/media/downloads/3_Publikationen/Agora_Energiewende_Kaptiztaetsmarktstudie.pdf> accessed 20.10.2015, p. 10.

capacity and correlations of scarcity with neighbour countries.[150] Furthermore, even if some countries take into consideration interconnected capacity, they do it in an uncoordinated way with no common definitions, scenarios, or methodology.[151] On this issue, ACER also indicates that "Member States currently have national and diverging approaches to security of supply with a lack of coordination among them."[152] Because of this lack of coordination, Member States generally undervalue the potential benefit of importing resources for security of electricity supply. It may also lead to distrust of the ability of cross-border resources to contribute to national generation adequacy needs. To cure this deficiency, in line with the suggestions of CEER[153] and Andoura,[154] generation adequacy, or more generally security of supply, assessments should be made at the regional and European levels. These assessments can be developed with the same understanding as the Security of Gas Supply Directive entered into force in 2010, which provided binding legal precautions to better prevent security of supply crises and ensures a harmonised response in an emergency condition at the national, regional, or European level.[155] Furthermore, as per Article 9 of the Security of Gas Supply Directive, every national competent authority must prepare a comprehensive risk assessment by taking into account all relevant and regional circumstances, various scenarios of exceptional gas and supply disruption, and the interaction and correlation of risks with other Member States, as well as the maximal interconnection capacity of each border entry and exit point.[156] The approach adopted by the European gas market can also be adapted to the European electricity market to develop a comprehensive methodology to assess generation adequacy on a wider level, by taking into account various circumstances and

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[150] CEER, 'Assessment of electricity generation in European countries', 03.03.2014 , <https://www.ceer.eu/documents/104400/-/-/a9517a5f-5a98-2974-dd61-e085c7971b53> accessed 05.06.2015, pp.32-33.

[151] *ibid*.

[152] ACER, 'Report on Capacity Remuneration Mechanisms and the Internal Market for Electricity', *Supra* note 15, p.15.

[153] CEER, 'Response to the European Commission Consultation Paper on Generation Adequacy, Capacity Mechanisms and the Internal Market in Electricity', 2013, p.10.

[154] ANDOURA S., 'Energy Solidarity in Europe: From Independence to Interdependence', July 2013, <http://www.notre-europe.eu/media/energysolidarity-andoura-ne-ijd-july13.pdf?pdf=ok> accessed 06.06.2015, pp.46-48.

[155] *ibid*.

[156] Regulation (EU) No 994/2010 of the European Parliament and the Council of 20 October 2010 concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC, (Text with EEA relevance), OJ L 295, 12.11.2010, pp.1-22.

correlations at the regional and European levels as well as the contribution of solar and wind resources to generation adequacy.

4.2 Respecting Contracted Capacity Obligations

Respecting contractual commitments by Member States is a precondition for opening national CRMs to cross-border participation in a proper way. In this context, Olmos and Perez-Arriaga note that "a true security of supply for electricity at EU level will only happen when import and export physical contracts have priority over any domestic demand without such contracts."[157] As also indicated by Olmos and Perez-Arriaga, this is a direct evaluation of Article 4.3 of the Security of Electricity Supply Directive, saying that: "[i]n taking the measures referred to in Article 24 of Directive 2003/54/EC [referring to the measures to be adopted in emergency situations] and in Article 6 of the Regulation (EC) No 1228/2003, Member States shall not discriminate between cross border contracts and national contracts."[158] The Commission[159] and Eurelectric[160] also interpret this Article in the same way.

Nevertheless, contrary to the spirit of this Article, many national electricity laws include clear provisions concerning the measures to be taken in stress times to interrupt exports.[161] This is a very serious challenge to be overcome to enable capacity trading across borders. The solution concerning this issue can be developed through mutual trust and cooperation among national competent authorities including TSOs, National Regulatory Authorities, and even governments alongside the Commission, ACER, and ENTSO-E. Responsibilities, rights, and risk allocations among relevant parties, in particular during concomitant scarcity events, should be defined in a coordinated way to enable cross-border capacity trading.[162]

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[157] OLMOS L. and PEREZ-ARRIAGA I. J., 'Regional Markets', in PEREZ-ARRIAGA I. J. (ed.), *Regulation of the Power Sector*, Springer, London 2013, p.533.
[158] *See*, Article 4.3 of Security of Electricity Supply Directive, *Supra* note 29.
[159] European Commission, 'Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Making the Internal Energy Market Work', *Supra* note 3, pp. 28-29.
[160] FEUK H., 'Options for coordinating different capacity mechanisms', *Supra* note 27, p.5.
[161] OLMOS L. and PEREZ-ARRIAGA I. J., 'Regional Markets' *Supra* note 157, p.533.
[162] HENRIOT A. and GLACHANT J. M., 'Capacity Mechanisms in the European Market: Now, but How?', *Supra* note 20, p.5.

4.3 Allocation of Interconnectors' Capacity

Intending to implement cross-border capacity trading naturally leads to the question of how to allocate the capacity of interconnectors for capacity products. This is undoubtedly one of the most challenging problems on the table. Even so, it must be solved to actualise cross-border capacity trading, since no foreign capacity resource can assure a MS with a CRM to perform its commitments without having reliable interconnector capacity. In order to solve this problem, a range of options for the allocation of interconnector capacity have been put forward. These options include Reservation of Transmission Capacity, Acquisition of Transmission Rights, Acquisition of Specific Interconnection Tickets, and No Constraints on Interconnection Access.[163] All of these options have their pros and cons, but none of them have been adopted as a common approach in European countries. Herein, it should be noted that the UK has adopted an interconnector-led approach to enable cross-border participation in its 2015 Capacity Auction.[164] This approach can be regarded as a subcategory of the approach of explicit cross-border participation. According to this approach, interconnectors themselves will be eligible for participation in the UK Capacity Auction. Based on the decision made, interconnectors will be treated as domestic resources. As bidding parties, interconnectors will become owners of a capacity agreement for one year up to the level of their de-rated capacity. Furthermore, their obligation will be the same as domestic resources. In other words, their obligation will be based on a "delivered-energy" model rather than a "declared-availability" model.[165] The UK Government defines this approach as an interim solution until a wider EU regime will be developed which would permit the direct cross-border participation from neighbour countries. This approach, however, is not impeccable either. In particular, the "delivered-energy" model and the ownership of interconnectors by National Grid, the British TSO, are matters of concern with regard to their compatibility with the EU

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[163] ROQUES F., 'Capacity Remuneration Coordinating European Capacity Mechanisms: Which Way Forward?', *Supra* note 18.

[164] DECC, 'Electricity Market Reform: Capacity Market supplementary design proposals and Transitional Arrangements and Proposed amendments to the Capacity Market Rules 2014 and explanation of some immediate amendments to the Capacity Market Rules 2014, Government Response', January 2015, <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/396566/Government_Response_to_CM_Supplemetary_Design_Consultation_v.pdf> accessed 06.06.2015.

[165] *ibid*. p. 9.

Target Model.[166] Therefore, it is fair to say that the interconnector-led method adopted by the UK, as accepted by the UK, also does not provide a final settlement for Member States. It is clear that without establishing a proper method for the allocation of interconnectors' capacity, cross-border capacity trading in European CRMs cannot be realised. Therefore, all relevant parties, including the Commission, ACER, ENSTSO-E, Member States, and other stakeholders, should come together to develop a European solution to this challenge.

4.4 No Double Counting

The no double counting principle is based on the understanding that the same capacity resource should not be able to participate in more than one CRM to get remuneration.[167] Certain regulatory arrangements should be put into place to prevent double counting of a capacity resource. Multiple participation to different CRMs can make sense under the condition that there should not be any overlapping commitments.[168] In other words, the same capacity resource theoretically can participate to more than one CRM as long as it makes commitments for different periods of neighbouring markets.[169]

A notable implementation to prevent double counting is used in the PJM Capacity Market, where the capacity owner must provide a letter of non-recallability persuading PJM that neither the energy nor capacity from this unit is recallable to any other jurisdiction.[170] To do this successfully in Europe, TSOs in particular should develop strict coordination among themselves to enable information flow from one TSO to another, regarding the situation of capacity resources.

5. Energy Union Strategy: A New Driving Force for Integration?

[166] *ibid*. pp. 8-9.
[167] FEUK H., 'Options for coordinating different capacity mechanisms', *Supra* note 27, p.6.
[168] ENTSO-E, 'Cross-border Participation to Capacity Mechanisms', 13.02.2015, <https://www.entsoe.eu/Documents/Publications/Position%20papers%20and%20reports/150213_ENTSO-E_Policy_paper_Capacity_Mechanisms.pdf> accessed 07.06.2015, p.9
[169] *ibid*.
[170] PJM, 'PJM Manual 18: PJM Capacity Market', 2015, p.50.

The previous part of this chapter suggested that European CRMs should be integrated through accepting foreign capacity resources. This is a clear necessity from both legal and economic perspectives. To realise this integration, four minimum regulatory requirements were put forward. At the end of the day, it is obvious that these requirements need several and huge changes in the EU energy regulatory framework. At this point, the EUS is crucial to succeed these changes.

The EUS was adopted in February 2015 at the heart of discussions regarding the adverse effects of unilateral CRMs in the EU Electricity Market. Therefore, an intense discussion has increasingly continued in recent years to answer the question of how to integrate European CRMs. For this reason, the emergence of the EUS with its potential to give a concrete answer to this contemporary question could be seen as a late but positive step. This does not mean that the EUS was created only for CRMs. However, it is not wrong to say that the EUS, if properly delivered, may provide the necessary regulatory framework to integrate European CRMs. Before discussing the interaction between the EUS and CRMs, it is worth analysing here what the EUS is.

5.1 What is Energy Union Strategy?

Since the very beginning, EU energy policy has been based on three columns: security, sustainability and competitiveness. In harmony with these eternal policy objectives, the EUS was also created to strengthen these main three columns. This is easily understood from the first sentence of the Framework Strategy for a Resilient Energy Union concerning the EUS: "The goal of a resilient Energy Union with an ambitious climate policy at its core is to give EU consumers – households and businesses – secure, sustainable, competitive and affordable energy."[171]

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[171] European Commission, 'Energy Union Package: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: A Framework Strategy for a Resilient Energy Union with Forward-Looking Climate Change Policy`, COM(2015) 80 final, Brussels, 25.02.2015, <http://eur-lex.europa.eu/resource.html?uri=cellar:1bd46c90-bdd4-11e4-bbe1-01aa75ed71a1.0001.03/DOC_1&format=PDF> accessed 26.02.2018, p.2.

In February 2015, the Commission issued a Communication providing a framework strategy to build a resilient European Energy Union.[172] Maros Sefcovic, the Vice President of the Commission responsible for the Energy Union, introduced it as "the biggest energy project since the Coal and Steel Community."[173] Essentially, it aims at consolidating current EU energy policy objectives, including the 2030 Framework for Climate and Energy and the European Energy Security Strategy, with a group of new measures into one coherent strategy.[174] In other words, the EUS intends to advance the integration process of 28 European energy markets to promote climate and energy security policies. Within the context of CRMs, the EUS remarks on the detrimental effects of unilateral generation adequacy policies and makes a commitment to work with Member States to ensure that CRMs are designed to be compatible with the current rules and that they do not distort the IEM.[175] It should be reiterated here that, as per the current legal framework, the Commission has limited competence to shape Member States' national energy policies. Therefore, it should be expected that the EUS can have some indirect results for national CRM design in Member States.

As one of the very first results of the Energy Union Strategy for CRMs, the Commission launched a State Aid sector inquiry into Member States' generation adequacy measures on 29 April 2015.[176] This sector inquiry focuses on 11 Member States including Belgium, Croatia, Denmark, France, Germany, Ireland, Italy, Poland, Portugal, Spain, and Sweden.[177] The Commission states that "[t]he sector inquiry aims to consolidate the Energy Union's objectives of secure and affordable energy supplies by ensuring that [CRMs] are competitive and market-based, as set out in the 2014 Energy and Environmental State Aid Guidelines in

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[172] *Ibid*.

[173] LEWIS B., 'EU chiefs launch biggest energy shake-up in half century', Reuters, 25.02.2015, <http://uk.reuters.com/article/2015/02/25/uk-eu-energy-grid-idUKKBN0LT0VK20150225> accessed 05.06.2015.

[174] ELLENBECK S. et al, 'Security of Supply in European Electricity Markets – Determinants of Investment Decisions and the European Energy Union', (2015) 8 *Energies* p.5208, pp.5198, 5216.

[175] European Commission, 'Energy Union Package: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: A Framework Strategy for a Resilient Energy Union with Forward-Looking Climate Change Policy`, *Supra* note 171, p. 10.

[176] European Commission, 'State Aid: Sector Inquiry into Capacity Mechanisms', Fact Sheet, 29.04.2015, <http://europa.eu/rapid/press-release_MEMO-15-4892_en.htm> accessed 05.06.2015.

[177] *ibid*.

the section on generation adequacy."[178] Within this scope, it could be said that the State Aid sector inquiry for CRMs does not have different objectives from standard State Aid investigations. However, as noted by the Commission, the State Aid sector inquiry will enable the Commission to collect the views from all relevant actors including Member States' authorities, generators, suppliers, demand response providers, and other stakeholders. By doing so, the Commission will get the chance to see the big picture in the area of European CRMs to develop an EU-wide harmonised regulatory framework regarding security of supply. Also, by launching a sector inquiry for whole Member States' CRMs, the Commission may aim to prevent some governments, such as France, from derogating from State Aid investigations by using the claim that their CRMs fall within the scope of a public service obligation rather than State Aid. Furthermore, the Commission may intend to gain time by investigating whole CRMs at the same time, and thus, prevent Member States from developing any new unilateral and uncoordinated CRMs in the near future.

Originally, the EUS was proposed in 2014 by Donald Tusk, the former Prime Minister of Poland and the current President of the European Council, to deal with the security of gas supply challenges derived from the dominant position of Russia against the EU.[179] As it is well-known, security of gas supply concerns in the EU again increased following the Ukraine crisis which stemmed from the annexation of Crimea by Russia in 2014.[180] At that time, in his article published in the Financial Times, Tusk laid emphasis on the importance of creating a single European body assigned to buy gas from Russia to break up the monopoly of Russian gas and

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[178] *ibid*.

[179] Although Europe's dependence on Russian gas is a matter of fact, degree of dependency is varied among Member States. Since this subject is out of scope of this article, it is not analysed here anymore. However, it should be kept in mind that EUS was initially put into words because of Russia's dominant position in the EU gas supply. For further information concerning gas relations between Russia and the EU*, See,* DE MICCO P., 'A cold winter to come? The EU seeks alternatives to Russian gas', October 2014, <http://www.europarl.europa.eu/RegData/etudes/STUD/2014/536413/EXPO_STU(2014)536413_EN.pdf> accessed 12.02.2016.

[180] It is a matter of common knowledge that every crisis between Russia and Ukraine endangers the EU gas supply security. This is a well-known fact that was proven several times in last decade. For the time timeline of gas crisis between Russia and Ukraine in last decade, *See* REUTERS, 'Timeline: Gas crisis between Russia and Ukraine', 12.01.2009 <http://www.reuters.com/article/us-russia-ukraine-gas-timeline-sb-idUSTRE50A1A720090112> accessed 12.02.2016

to restore free market competition.[181] To that end, Tusk proposed a European Energy Union based upon five principles: (1) Developing a mechanism for unitedly negotiating gas contracts with Russia; (2) Developing mechanisms that guarantee solidarity among Member States in case of gas supply crisis; (3) Constructing necessary infrastructure investments such as storage and pipelines with the support of the EU; (4) Allowing the use of all fossil fuels including shale gas and coal as long as full energy security can be sustainably ensured; and (5) Diversifying gas supply routes through new LNG agreements with, for instance, the US and Australia.[182] As can be understood from these principles, Tusk's proposal sought to establish an Energy Union involving only security of gas supply issues with the aim of reducing European dependence on Russian gas. However, the scope of Tusk's proposal has gained a far larger dimension.[183] Its scope is now embracing the entirety of EU Energy Policy and, in this sense, the EUS can be viewed as a cornerstone for a sea-change in EU energy market structures to achieve energy transition.

With this understanding, the Commission published a Communication as Framework Strategy in February 2015 to identify the strategy introducing how to realise the EUS. According to this Framework Strategy, the EUS is composed of five interdependent dimensions: (1) energy security; (2) a fully integrated energy market; (3) energy efficiency; (4) decarbonisation; and (5) research and innovation.[184] Based on these five interdependent dimensions, the EUS intends to put an end to the disunity of energy regulatory frameworks among Member States. In the Framework Strategy for a Resilient Energy Union, the Commission noted that:

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[181] TUSK D., 'A united Europe can end Russia's energy stranglehold', <http://www.ft.com/cms/s/0/91508464-c661-11e3-ba0e-00144feabdc0.html#axzz3yX4oQl4w> accessed 12.02.2016.

[182] *ibid*.

[183] BUCHAN D. and KEAY M., 'Europe's 'Energy Union' plan: A reasonable start to a long journey', The Oxford Institute for Energy Studies, Oxford Energy Comment, March 2015, <http://www.oxfordenergy.org/wpcms/wp-content/uploads/2015/03/Europes-Energy-Union-plan-a-reasonable-start-to-a-long-journey.pdf> accessed 12.02.2016, p.2.

[184] European Commission, 'Energy Union Package: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: A Framework Strategy for a Resilient Energy Union with Forward-Looking Climate Change Policy`, *Supra* note 171, p.4.

> "Today, the European Union has energy rules set at the European level, but in practice it has 28 national regulatory frameworks. This cannot continue. An integrated energy market is needed to create more competition, lead to greater market efficiency through better use of energy generation facilities across the EU and to produce affordable prices for consumer."[185]

Among other objectives, the Framework Strategy provided special attention to the late developments in the EU electricity markets. The Commission clearly admitted the inadequacy of the current security of electricity supply framework and noted that the current outdated and inconsistent security of supply framework will be modernised.[186] In this sense, three main points are emphasised in the Framework Strategy which can be considered as directly related to CRMs: (1) Strict enforcement of the current energy related legislation to monitor Member States' actions;[187] (2) Proposing new legislation in relation to new electricity market design and security of electricity supply framework; and (3) Improving coordination among Member States through enhancing ACER and ENTSO-E.[188]

5.2 The Interaction between the EUS and CRMs

As indicated above, the EUS' sphere of influence is much broader than CRMs. However, efforts to integrate European CRMs have gained a strong point of support with the EUS. The reason behind this evaluation is that the EUS is intended to create a new legislative and regulatory framework that governs energy relations at the EU level rather than national level. As discussed above, under the current system, the Commission can only examine national measures to ensure security of electricity supply, for instance CRMs, through rules on State

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[185] *ibid*, p.3.
[186] *ibid*, p.6.
[187] With regard to CRMs, the very first result of this point is the State Aid Sector Inquiry launched in April 2015 to scrutinize whether CRMs in eleven Member States are compatible with State aid rules. This issue is tackled below.
[188] European Commission, 'Energy Union Package: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: A Framework Strategy for a Resilient Energy Union with Forward-Looking Climate Change Policy`, *Supra* note 171, pp.19-20.

Aid and the Free Movement of Goods. However, clearly a thorough IEM cannot be established and managed through only these two legal tools.[189] Therefore, improving the current regulatory framework and changing the current mindset regarding security of electricity supply is a pre-condition to ensure a secure, competitive and sustainable internal electricity market in the EU. In this sense, the EUS may provide a route map for the near future on answering how integration among national energy policies will be realised.

5.2.1 State Aid Sector Inquiry for CRMs

An initial result of the EUS is that the Commission launched a State Aid sector inquiry to investigate whether CRMs in 11 Member States including Belgium, Croatia, Denmark, France, Germany, Ireland, Italy, Poland, Portugal, Spain, and Sweden are compatible with EU Law.[190] The Commission explained the link between the sector inquiry and the EUS by saying that:

> "[t]he sector inquiry aims to consolidate the Energy Union's objectives of secure and affordable energy supplies by ensuring that capacity mechanisms are competitive and market-based, as set out in the 2014 Energy and Environmental State Aid Guidelines in the section on generation adequacy."[191]

Within this context, it can be argued that the Commission may expect the sector inquiry to prevent Member States from developing any more uncoordinated CRMs in their jurisdictions until the end of the inquiry. Also, the Commission may intend to prevent Member States, such as France, to derogate State Aid approval from the Commission by claiming their CRMs fall within the scope of public service obligations.[192] In line with this argument, in November 2015,

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[189] Jean-Michel Glachant, in his interview on Energypost, argues that Energy Union is only a dream for the EU as long as the Commission's power is limited to internal market and competition law. *See* RENSSEN S., 'Interview Jean-Michel Glachant: "To get an Energy Union, you need new institutions"', 24.02.2015, <http://www.energypost.eu/interview-jean-michel-glachant-get-energy-union-need-new-institutions/> accessed 13.02.2016.

[190] European Commission, 'State Aid: sector inquiry into capacity mechanisms', *Supra* note 176.

[191] *ibid*.

[192] COIBON A. and PICKETT J., 'Capacity Mechanisms: Reigniting Europe`s Energy Markets', *Supra* note 45, p. 14.

the Commission launched two in-depth investigations to decide whether the French CRM (capacity obligations) and a tender for attracting a new gas power plant in Britanny are compatible with State Aid rules.[193] In February 2016, according to two decisions (not final), both schemes in France were regarded as State Aid within the meaning of TFEU.[194]

5.2.2 Enacting necessary legislation

Integrating European CRMs requires a new regulatory framework that enable well-functioning cross-border participation. In this sense, the Security of Electricity Supply Directive should be modernised to adapt to changing needs. As a well-known fact that compared to other areas of energy market, security of electricity supply in the EU has remained mostly a national issue. Therefore, Andoura and Vinois defined it as the weakest element of the EU energy market.[195] In this regard, in the Framework Strategy, the Commission declared that new legislation on security of electricity supply will be proposed within 2016.[196] With this change, it can be expected that the issue of generation adequacy will be tackled at the regional and European level rather than national level. At this juncture, it is not hard to guess that the Security of Electricity Supply Directive will be designed in

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[193] European Commission, 'State Aid: Commission opens in-depth investigations into French plans to remunerate electricity capacity', Press Release, Brussels, 13.11.2015, <http://europa.eu/rapid/press-release_IP-15-6077_en.htm> accessed 13.02.2016.

[194] European Commission, 'State aid — France — State aid SA.39621 (2015/C) (ex 2015/NN) — Capacity mechanism in France — Invitation to submit comments pursuant to Article 108(2) of the Treaty on the Functioning of the European Union, OJ C 46, 05.02.2016, pp.35-69; European Commission, 'State aid — France — State aid — Notified State aid SA.40454 (2015/C) (ex 2015/N) — France — Call for tenders for additional capacity in Brittany — Invitation to submit comments pursuant to Article 108(2) of the Treaty on the Functioning of the European Union' OJ C 46, 05.02.2016, pp.69-88.

[195] ANDOURA S. and VINOIS J. A., 'From the European Energy Community to the Energy Union: A Policy Proposal for the Short and the Long Term', January 2015, <http://www.institutdelors.eu/media/energyunion-andouravinois-jdi-jan15.pdf?pdf=ok> accessed 14.02.2016, p.57.

[196] European Commission, 'Energy Union Package: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: A Framework Strategy for a Resilient Energy Union with Forward-Looking Climate Change Policy`, *Supra* note 171, p.20.

analogy to the Security of Gas Supply Directive.[197] A document prepared by the Commission also shows how possible changes to the Security of Electricity Supply Directive will be made.[198] Furthermore, as indicated by the Framework Strategy, the Commission will propose a new electricity market design for Europe within 2016.[199] A new electricity market design in the EU is a necessity because a range of big changes have taken place in recent years, including: (1) RES has become the prominent electricity resource; (2) Decentralised electricity generation has proliferated; and (3) Flexible demand participation to electricity markets have become more important.[200] Naturally, these breakthrough developments bring about new opportunities and, of course, new risks. Therefore, the new electricity market design in the EU should be prepared in accordance with the changing conditions of the industry. At this point, the new electricity design should be prepared by taking account the reality of CRMs in the EU.

5.2.3 Improving institutional framework

Two critical supranational institutions, ACER and ENTSO-E, for the EU electricity market were established by the Third Energy Market Package to implement coordination among NRAs and TSOs in the EU.[201] However, their powers and responsibilities have always been very limited to fulfil this duty. Hence, within the context of the EUS, it is intended to strengthen their role. For instance, the Framework Strategy says about the role of ACER that: "EU-wide regulation of the single market should be strengthened, through a significant reinforcement of the

[197] On this matter, a brief discussion is made above under the subheading of 'Harmonized Generation Adequacy Assessments'.

[198] European Commission, 'Evaluation of the EU rules on measures to safeguard security of electricity supply and infrastructure investment (Directive 2005/89)', <http://ec.europa.eu/smart-regulation/roadmaps/docs/2016_ener_032_evaluation_elec_supply_investment_en.pdf> accessed 19.02.2016.

[199]European Commission, 'Energy Union Package: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: A Framework Strategy for a Resilient Energy Union with Forward-Looking Climate Change Policy`, *Supra* note 171, p.20

[200] European Commission, 'Consultation on a new Energy Market Design', <https://ec.europa.eu/energy/en/consultations/public-consultation-new-energy-market-design> accessed 15.02.2016.

[201] European Commission, 'Energy Union Package: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: A Framework Strategy for a Resilient Energy Union with Forward-Looking Climate Change Policy`, *Supra* note 171, p.9.

powers and independence of ACER to carry out regulatory functions at the European level […]"[202] In this regard, Andoura and Vinois proposed that ACER should be empowered to such a level that it can take binding decisions on cross-border issues and be provided adequate resources to fulfil all tasks including network codes, infrastructures and market operations.[203] In a similar vein, they suggest that ENTSO-E also should also be empowered to coordinate electricity flows throughout the EU in real time.[204] Even though their views show the basic necessity of the EU to integrate unilateral CRMs, it should be noted that empowering these institutions, especially ACER, to that extent can be very hard. This is clearly understood from the preliminary results of the public consultation on Electricity Market Design. According to these results, although there is considerable support to increase ACERs legal power and responsibilities over ENTSO-E and NRAs, Member States and NRAs particularly want to protect the current status quo.[205] A similar division is observed for ENTSO-E as well.[206] It could be argued that Member States will try to protect their regulatory power over their jurisdictions. Therefore, expecting any serious change in the current situation, at least for the near future, is unrealistic. However, it is also unrealistic to achieve a well-functioning integration among unilateral CRMs under the current institutional framework. Therefore, as referred to several times in this research, improving coordination among TSOs and NRAs will be much more crucial. Cooperation among Member States is not enough. This cooperation should be supported by political commitments and common goals concerning security of supply based on mutual trust. It can be expected that the EUS will promote this process. For instance, in early June 2015, 12 European countries including Germany, Denmark, Poland, Czech Republic, Austria, France, Luxembourg, Belgium, the Netherlands, Sweden, Switzerland and Norway signed a declaration for regional cooperation on security of supply in the IEM.[207]

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[202] *ibid*.
[203] ANDOURA S. and VINOIS J. A., 'From the European Energy Community to the Energy Union: A Policy Proposal for the Short and the Long Term*', Supra* note 195, p.108.
[204] *ibid*., p.109.
[205] European Commission, 'Preliminary results from the public consultation on Electricity Market Design', <https://ec.europa.eu/energy/sites/ener/files/documents/First%20Results%20of%20Market%20Design%20Consultation.pdf> accessed 14.02.2016.
[206] *ibid*.
[207] European Commission, 'Energy Union: Advancing the integration of European energy markets', Press Release, 08.06.2015, <http://europa.eu/rapid/press-release_IP-15-5142_en.htm> accessed 12.06.2015.

In addition to this declaration, Austria, Belgium, France, Germany, Luxembourg and the Netherlands signed the Second Political Declaration of the Pentalateral Energy Forum.[208] These are remarkable developments in order to achieve the integration of European CRMs and they form a starting point of a long journey. As indicated by the DECC, "[a] lot of work has gone in over the past two decades on enabling electricity to be traded internationally and now "capacity" must be defined and specified to enable it to be similarly traded."[209]

6. Brexit and its Potential Implications on the Integration of European CRMs

6.1 Brexit: Definition and its timeline

"I deal with tough mathematical questions every day, but please don't ask me to help with Brexit."[210] Stephen Hawking, one of the most famous and intelligent physicists and cosmologists ever, said these words while Theresa May, the current Prime Minister of the UK, gave him a lifetime achievement award at the Pride of Britain Awards. Hawking explained his request by saying that: "Brexit is too complex even for me."[211] Obviously, Hawking made a nice joke with a deep sense of humour that he had. But again, obviously Hawking's joke contained a great truth. Before coming to the complexity created by Brexit, it is worth to give a short definition of Brexit and its timeline.

Brexit is a term used as an abbreviation for British and Exit. Brexit, as one of the most popular concepts of recent years especially throughout Europe, is a concept employed to describe the UK's departure process from the EU. This departure process was legally started with a

[208] PENTALATERAL ENERGY FORUM, 'Second Political Declaration of the Pentalateral Energy Forum of 8 June 2015', 2015, <http://www.bmwi.de/BMWi/Redaktion/PDF/P-R/pentalateral-energy-forum-second-political-declaration,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf> accessed 12.06.2015.
[209] DECC, 'Electricity Market Reform: Capacity Market: Consultation on Capacity Market supplementary design proposals and Transitional Arrangements', September 2014, <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/358461/CM_October_Condoc_FINAL.pdf> accessed 05.06.2015, p.17.
[210] OPPENHEIM, M., 'Stephen Hawking: Brexit is too complex even for me', 01.11.2016, <http://www.independent.co.uk/news/people/stephen-hawking-brexit-is-too-complex-even-for-me-pride-of-britain-awards-a7391701.html> accessed 10.03.2018.
[211] *Ibid*.

referandum held on 23th of July, 2016. In this referandum, 51.9% of British voters decided to leave the EU.

Table 10 Brexit Timeline[212]

January 23, 2013	David Cameron, the former Prime Minister of the UK, made a speech at Bloomberg and declared that he is supporting a in or out referendum for a new settlement between the UK and the EU.
April 14, 2015	The Conservative Party as the party in power published an election manifesto that pledged a fundamental change in relationship between the UK and the EU, and committed to hold a referendum to allow the British citizens to decide whether their country continue to be a member of the EU or not.
December 17, 2015	Royal Assent was provided for the European Union Referendum Act 2015.
February 22, 2016	The Prime Minister David Cameron announced the referendum date as 23 June 2016. The question for the referendum was designed as *"Should the United Kingdom remain a member of the European Union or leave the European Union?".* Answers to this question were to appear on ballot papers as "*Remain a Member of the European Union* or *Leave the European Union*".

212 Prepared by the author based on the following sources, *See* WALKER, N., 'Brexit timeline: events leading to the UK's exit from the European Union', Briefing Paper, 2018, <https://researchbriefings.parliament.uk/ResearchBriefing/Summary/CBP-7960#fullreport> accessed 10.10.2018; The Economist, 'In Graphics: Bretain's Referandum on EU membership: A background guide to "Brexit" from the European Union', 2016, <https://www.economist.com/graphic-detail/2016/02/24/a-background-guide-to-brexit-from-the-european-union> accessed 10.10.2018; European Union Referendum Act 2015, 'The Referendum', <http://www.legislation.gov.uk/ukpga/2015/36/crossheading/the-referendum/enacted> accessed 10.10.2018; European Council, 'Guidelines Following the United Kingdom's Notification Under Article 50 TEU', 29.04.2017, <https://www.consilium.europa.eu/media/21763/29-euco-art50-guidelinesen.pdf> accessed 07.10.2018; Department for Exiting the European Union, 'The EU (Withdrawal) Bill receives Royal Assent', 26.06.2018, <https://www.gov.uk/government/news/the-eu-withdrawal-bill-receives-royal-assent> accessed 07.10.2018; Department for Business, Energy & Industrial Strategy, 'Publications', <https://www.gov.uk/government/publications?departments%5B%5D=department-for-business-energy-and-industrial-strategy> accessed 16.10.2018; European Council, 'Informal meeting of heads of state or government', 19.09.2018 – 20.09.2018, <https://www.consilium.europa.eu/en/meetings/european-council/2018/09/19-20/> accessed 08.10.2018; <European Council, 'Remarks by President Donald Tusk after the Salzburg informal summit', Press Release, 20.09.2018, <https://www.consilium.europa.eu/en/press/press-releases/2018/09/20/remarks-by-president-donald-tusk-after-the-salzburg-informal-summit/> accessed 08.10.2018; European Council, Meeting Main Results, 18.10.2018, <https://www.consilium.europa.eu/en/meetings/european-council/2018/10/18/> accessed 19.10.2018.

April 11-13, 2016	A leaflet was published on 6th of April, 2016 by the UK Government to explain its position for the referendum. This leaflet, with the head of *why the Government believes that voting to remain in the European Union is the best decision for the UK*, was delivered to every household between 11th and 13th of April, 2016 in the UK. In this leaflet, the Government supported the membership of the EU based on the arguments that continuing to be a member of the EU can protect jobs, improve the British economy and provide security. Nevertheless, it should be noted that although the Government clearly stated that it favoured the continuation of the EU membership of the UK, some prominent figures of the Conservative Party including Michael Gove, who was Secretary of State for Justice between 2015 and 2016, and Boris Johnson, who was Mayor of London between 2008 and 2016, pledged to support "out" campaign.
June 23, 2016	Referendum on the UK's membership of the EU was held and, as a result, 51.9% of the British voters chose to leave the EU.
June 24, 2016 – July 13, 2016	David Cameron announced his intention to resign from prime ministry on 24 June 2016. Theresa May became the new prime minister of the UK.
March 29-30, 2017	Theresa May triggered the Article 50 of TFEU on 29 March 2017 and the UK Government published the Great Repeal Bill White Paper on 30 March 2017.
April 29, 2017	The European Council in its special meeting unanimously (EU 27 excluding the UK) adopted its negotiation guideline. According to this guideline, it was decided that negotiations under Article 50 would be conducted as a single package which is based on the principle of "nothing is agreed until everything is agreed, individual items cannot be settled separately." It was also stated that there would be no separate negotiations between any MS and the UK. Hence, the EU had the chance to conduct negotiations with the UK as a single body. Furthermore, at the very beginning of the negotiations, the European Council clearly and strongly manifested that four freedoms which constitute the single market are inseparable and, in this sense, "cherry picking" method is not acceptable.
June 7, 2017 – June 19, 2017	A general election was held on 7 June 2017 in the UK and resulted in a hung parliament. Under the leadership of Theresa May, the Conservative Party formed the government and, thus, the first round of negotiations were started on 19 June 2017.
July 13-14, 2017	The Government introduced the European Union (Withdrawal) Bill on 13th July, 2017. And, the second round of negotiations began on 14th of July, 2017.
August 27, 2017	The third round of negotiations began on 27th of August, 2017.
September 25, 2017	The fourth round of negotations began on 25th of August, 2017.
October 9, 2017	The fifth round of negotiations began on 9th of October, 2017.

June 26, 2018	The EU (Withdrawal) Bill got Royal Assent on 26th June, 2018 and officially became law.
July 17, 2018 (Updated date)	The Government published a policy paper on "The future relationship between the United Kingdom and the European Union" which is also known as "Chequers Plan". Because of this plan, David Davis, Brexit Minister, and Boris Johnson, Foreign Minister, resigned.
September 19-20, 2018	On 19th of September, 2018, Heads of EU Governments or States gathered at an informal meeting in Salzburg in order to discuss Brexit as well as other issues such as internal security and migration. After this meeting, Donald Tusk, President of the European Council, remarked that *"Everybody shared the view that while there are positive elements in the Chequers proposal, the suggested framework for economic cooperation will not work. Not least because it risks undermining the Single Market."*
October 12, 2018	The Government published a set of papers drafted as plans as a preparation for 'No deal' scenario. These papers were covering a range of areas including trading electricity and gas, climate change, accounting and auditing, consumer rights, business.
October 17, 2018	EU27 leaders met on 17th of October, 2018 to discuss the state of the negotiations between the UK. Before the meeting, Theresa May made a speech to the EU27 leaders to put forward the UK perspective concerning the negotiations. After the meeting, EU27 leaders declared that *"despite intensive negotiations, not enough progress has been achieved."*

6.2 Brexit and Integration of the European CRMs: Complicating But Not Insurmountable

The Brexit process has already created many complex challenges to be overcome. These challenges cover every aspect of life from economics to law, from politics to defence, from labour market to international trade. Positions taken by the parties before the negotiations make Brexit even more complicated. As shown in the table below, the redlines determined by the parties before the Brexit negotiations were completely poles apart. These completely opposite attitudes naturally reduce the chances of success of the negotiations.

Table 11 Starting Points of the UK and the EU for the Brexit Negotiations[213]

Redlines of the UK	Redlines of the EU
No more Free movement	Free movements of persons, goods, services and capital are indivisible
Full autonomy of the UK Laws	Sector by sector participation to the Single Market is not possible
Autonomy to conclude its own trade agreements	the EU preserves its autonomy as regards its decision-making and the role of the European Court of Justice
No role for the European Court of Justice	

Giving some statistics on this matter would be useful to show how complex the issue is. According to a study conducted by Financial Times, in case 'No deal' scenario, the UK will have to re-approach 168 countries to renegotiate at least 759 treaties covering the areas of trade, regulatory co-operation, fisheries, transport, customs, nuclear and agriculture.[214] As per a further statistic, over 20,000 EU laws and rules are affected due to Brexit and 378 of them are related to the energy sector.[215] Unsurprisingly, energy industries including electricity markets in both the UK and the EU will be profoundly affected from the Brexit process. There is a growing body of literature, including Little[216], Lockwood et al[217], Lowe[218], LaMaster and Hammerson[219], that has been analysing the potential implications of Brexit for the energy sector in Europe. Researchers who study about the potential implications of Brexit on energy sector are analysing the different aspects of the issue. As this research is about the integration of European CRMs, a brief discussion is made here concerning how Brexit would affect the capacity trading across borders between the UK and the EU.

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213 Prepared by the author based on following source, *See,* 'Energy Files Brexit Implications for the Energy Sector', (2017), 7 *European Energy Journal*, pp.5-9, pp.5-6.
214 MCCLEAN, P., 'After Brexit: the UK will need to renegotiate at least 759 treaties', 30.05.2017, <https://www.ft.com/content/f1435a8e-372b-11e7-bce4-9023f8c0fd2e> accessed 10.10.2018.
215 BAUME, M.D.L. et al, '13 things you didn't know about Brexit', 17.08.2017, <https://www.politico.eu/article/brexit-negotiation-issues-worrying-the-european-parliament/> accessed 10.10.2018.
216 LITTLE, G., 'Brexit and Energy in Scotland', (2018), 22 *Edinburgh Law Review*, pp.144-149.
217 LOCKWOOD, M. et al, 'The implications of Brexit for the electricity sector in Great Britain: Trade-offs between market integration and policy influence', (2017), 110 *Energy Policy*, pp.137-143.
218 LOWE, P., 'Brexit and Energy: Time to Make Some Hard Choices', (2018) 7 *European Energy Journal*, pp.38-46.
219 LAMASTER, J.C. and HAMMERSON, M., 'Brexit and the UK Oil & Gas Sector', (2016), 28 *Denning Law Journal*, pp. 9-15.

Throughout this chapter, it was discussed why the European CRMs should be integrated. Both economic and legal justifications of this integration were examined one by one. In this sense, it is evident that Brexit will shake the legal grounds for the integration of the UK capacity market with the other European CRMs. The reason for this is that it is currently unclear whether or not the UK will continue to be bound with the European Single Market Rules. In case the UK leaves the EU Single Market, it remains also unclear on what conditions the UK will continue trade with the EU. Recent developments put forward that the Brexit negotiations can result with a "No deal". In case a No-deal scenario, it is obvious that the UK will become a third country[220] for the EU. At this juncture, asking the question of whether capacity trading (i.e. integration of CRMs within the understanding of this thesis) between the UK and MSs can be achieved is legitimate. The answer is simply "yes". On the other hand, how to achieve a cross border capacity trading between the UK electricity market and the EU IEM has no easy answer. Principally, capacity trading across borders between the UK and the EU can be realized as long as minimum regulatory requirements for capacity trading across borders are met. As mentioned before in this chapter, four regulatory requirements were defined in order to make capacity trading across borders possible. As a reminder, these regulatory requirements are as follows: (1) Harmonized Generation Adequacy Assessments, (2) Respecting Contracted Capacity Obligations, (3) Allocation of Interconnectors' Capacity and (4) No double Counting Principle. In order not to repeat, these regulatory requirements are not individually explained here. Nevertheless, it should be critically noted that these requirements are not only valid for the EU. As long as any two adjacent electricity markets in any part of the world meet these regulatory requirements, capacity trading among these electricity markets can be achieved. In this sense, it could be said that, even in 'no deal' case, since a kind of agreement covering energy matters can be expected to be concluded between the UK and the EU, this agreement will probably serve as a legal ground for capacity trading as well as other energy issues. This makes sense because the UK has to continue electricity trade including capacity trading with the EU due to particularly its geographical location and

[220] For the EU Law, the term 'third country' is used for countries which are not member of the EU. *See* EUROFOUND, 'Third-country nationals', 11.07.2007, <https://www.eurofound.europa.eu/observatories/eurwork/industrial-relations-dictionary/third-country-nationals> accessed 10.10.2018

shared energy policy objectives including low-carbon future. Otherwise, the UK will have to invest more in more generation capacity, pay higher prices for energy, have less security of supply and admit bigger role for the governmental intervention in the energy industry.[221] Furthermore, for instance, according to an estimation:

> “In a worst-case scenario, under a "no deal" Brexit that cuts Northern Ireland's power system off from the independent Republic of Ireland, the north could expect blackouts and steep electricity price hikes starting in March 2019, when the United Kingdom departs the European Union.”[222]

Last but not least, it is worth mentioning one of the most important points regarding capacity trading across borders. It was stated above that four minimum regulatory requirements laid down in this thesis for capacity trading across borders are not valid only for the Single Market of the EU. Examples in the world support this argument. For instance, New England and Canada are able to implement capacity trading, although they are separate jurisdictions and have not any single market such as the EU. ISO New England announced at the beginning of 2018 that it had secured 1217 megawatts of import capacity from New York and Canada in its auction held for 2021-2022 electricity needs.[223] Likewise, PJM capacity market cleared 4051.8 megawats of import capacity in its last auction held for 2021-2022 electricity needs.[224] These statistics also reveal that EU Single Market Rules are not required for capacity trading across borders. After the necessary arrangements are made, any two neighboring electricity market can implement capacity trading. In this sense, even if the UK is leaving the Single Market with ‘no deal’, it will be able to continue to capacity trading with EU MSs as a third country with other legal arrangments.

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221 LOWE, ‘Brexit and Energy: Time to Make Some Hard Choices’, *Supra* note 218, p.46.
222 SMITH, A.C., ‘As Brexit looms, Northern Ireland faces power shortages, political turmoil’, 2018, <https://platform.mi.spglobal.com/web/client?auth=inherit#news/article?id=46817829&cdid=A-46817829-10792> accessed 17.10.2018.
223 SERREZE, M.C., ‘ISO New England secures plenty of power capacity for the region’s 2021-2022 electricity needs’, 2018, <https://www.masslive.com/business-news/index.ssf/2018/02/region_has_plenty_of_power_capacity_for.html> accessed 17.10.2018.
224 PJM, ‘2021/2022 RPM Base Residual Auction Results’, 2018, < https://www.pjm.com/-/media/markets-ops/rpm/rpm-auction-info/2021-2022/2021-2022-base-residual-auction-report.ashx> accessed 17.10.2018.

7. Conclusion

This chapter first determined that CRMs in the EU Member States have been mostly established with a national-only approach in an uncoordinated and fragmented way. Subsequently, this research argued that national CRMs should be integrated, based on economic and legal necessities. It further indicated that the integration of national CRMs can be achieved through allowing cross-border participation, which seems more practical than having EU or regional-wide CRMs. Although implicit cross-border participation is regarded as an interim solution for integration, there is consensus among all relevant actors including the Commission, ACER, and Member States that explicit cross-border participation can provide generation adequacy with higher efficiency and lower costs. Nevertheless, there are several complex challenges to be overcome to enable cross-border capacity trading, which can be possible with explicit cross-border participation. To overcome these challenges, this chapter suggested some minimum requirements for capacity trading across borders, including Harmonised Generation Adequacy Assessments, Respecting Contracted Capacity Obligations, Allocation of Interconnectors' Capacity, and No Double Counting. All these requirements commonly call for stronger cooperation among Member States. Cooperation among Member States is not enough. This cooperation should be supported by political commitments and common goals concerning security of supply based on mutual trust. It can be expected that the EUS will promote this process. If the EUS is delivered properly and provides the necessary regulatory framework at the regional and EU level, the type of integration of European CRMs would turn from negative into positive integration. It is obvious that this is not an easy road to travel. Nevertheless, the EUS should be accepted as an unmissable chance to prevent the further fragmentation of the EU electricity markets. In this sense, three key points of contact between CRMs and the EUS including the State Aid Sector Inquiry for CRMs, enacting necessary legislation and Improving Institutional Framework are specified in this study. These interaction points may make the integration of the EU CRMs a possibility in the near future. Of course, further research must be conducted to test a lot questions such as whether the legislation brought by the EUS is adequate for this integration, whether the Improved Institutional Framework achieved by the EUS provides sufficient authority for supranational EU institutions such as ACER and ENTSO-E to implement and monitor this integration process. Furthermore, how the EUS may unearth the CRMs potential regarding their ability to integrate alternative capacity resources to the EU electricity markets. This is a highly critical question because CRMs as incentive mechanisms would be the star of energy transitions by incentivising these capacity resources if they are well designed and target specific.

CHAPTER 5 - GENERAL CONCLUSION

1. General Overview of the Thesis

This thesis has painted a general picture of electricity markets in the EU within the context of CRMs. As discussed in Chapter 1, Introduction, liberalisation created serious challenges for the EU Member States to ensure generation adequacy in their electricity markets. These challenges have emerged especially since the beginning of this decade for many Member States in the EU. For this reason, many Member States including the UK, Germany, France, Italy, Belgium, Poland, Denmark, Spain, Portugal, Greece, Croatia, Sweden and Ireland have established their own CRMs in their jurisdictions, and all CRMs established in Member States have been so unilaterally. This means that Member States establishing CRMs have either never considered or sufficiently considered neighbour countries' contribution to their generation adequacy. However, as discussed in this thesis, establishing CRMs with a unilateral approach in integrated electricity markets, as in Europe, may lead to inefficiencies and distort cross-border trade. These developments raise the following controversial question: How does one create a regulatory framework to integrate European CRMs. This was defined as the main research problem to be answered within the context of this thesis. In this context, the question of what regulatory framework would enable the integration of European CRMs constituted the main agenda of this research.

Before answering this question, first, a Conceptual Framework was provided to comprehend why energy-only markets may not produce adequate capacity investment to ensure generation adequacy. This was the second research aim of this thesis. In actual fact, this question was a pioneer for the question mentioned above, which explored how to integrate capacity markets in Europe. In this regard, in Chapter 2, a general evaluation was made about the increasing concerns in energy-only markets regarding generation adequacy. Chapter 2 started with a discussion for terminological clarification. Within this scope, the concept of reliability of electricity supply was investigated with its sub-concepts including security, firmness and adequacy. Thus, the sub-concept of generation adequacy and its position within the concept of reliability was determined. This was important since throughout this thesis generation adequacy was examined within the context of CRMs. Following this terminological clarification, the question of why generation adequacy is a problem in energy-only markets was analysed through carrying out an extensive literature. Several market imperfections or structural problems of electricity markets were put forward that prevented energy-only markets from producing adequate incentives to keep existing capacity online and/or attract new capacity investment. These market imperfections can be ordered as public good characteristic of reliability, the missing money problem, the rise of intermittency, investment cycle problem and the lack of adequate forward markets in energy-only markets. Due to these structural problems of energy-only markets, many countries around the world have established different types of CRMs in their jurisdictions. At the end of Chapter 2, different types of CRMs including capacity payments, strategic reserves, capacity obligations, capacity markets and reliability options were individually examined. In accordance with the results of previous studies, a table was also provided which compared the type of CRM in terms of different criteria. Indeed, this thesis was not an attempt to provide a comparative study for understanding which CRM is better or worse. In literature, there exists a broad number of studies devoted to comparing different CRMs from different points of view. Nonetheless, as noted, the end part of Chapter 2 provided a comparison in light of this literature. The main aim of this comparison was to pave the way for comprehending the different structures and working principles of each CRM. This was vital since throughout the thesis, CRMs have been analysed from different perspectives; therefore, understanding their basic characteristics was a necessity to underlying the approach adopted in this thesis.

Chapter 2 provided a General Conceptual Framework to be tested in the following part of the thesis, Chapter 3. With this understanding, Chapter 3 was devoted to exploring the main reasons of CRMs established in the EU since the beginning of this decade. It can be said that the reasons for the establishment of European CRMs are mostly the same as that suggested by the Conceptual Framework provided in Chapter 2. Accordingly, the main reasons that led to the establishment of the European CRMs can be ordered as the public good characteristic of reliability, the missing money problem, the rise of intermittency and the lack of adequate forward markets in energy-only markets. In addition to these reasons, Chapter 3 put forward that there are some European-centric reasons for the establishment of CRMs in the EU. These European-centric reasons are: (1) Low carbon prices – Failure of the ETS Scheme; (2) Phasing out nuclear and coal power plants; (3) The flood of cheap shale gas increasing the competitiveness of coal power plants; and (4) The 2008 Global Financial Crisis. All these causes have detrimentally affected the generation adequacy of Member States, albeit at different levels of severity, since the beginning of this decade. Here, it can be said that while the first group of causes led to the establishment of European CRMs are structural problems derived from the unique characteristic of electricity markets, the second group of problems (European-centric reasons of European CRMs) can be mostly regarded as cyclical challenges. So, overcoming and/or managing the first group of causes of European CRMs will take more time for Member States over the next decade. In particular, it is not difficult to expect that intermittent RESs, which is increasingly influential in the EU, will increase the need for CRMs to overcome the challenges concerning generation adequacy. However, at the end of the day, there is no doubt that all the above-mentioned causes are more or less responsible for the beginning of the age of CRMs in Europe.

The last main part of the thesis, Chapter 4, is the main aim of this research. The reason for this is that it was totally about the regulatory framework that is required to integrate the European CRMs. Chapter 4 started with a definition of the integration of CRMs. Within the context of this research, integration of CRMs was defined as accepting foreign capacity resources, where physically possible, to national CRMs under the same conditions with domestic capacity resources. Following this definition, possible levels or types of integration such as (1) creating a single European CRM or establishing regional-wide CRMs and (2) allowing cross-border participation implicitly or explicitly were examined. It was concluded that for practical reasons, implicit or explicit cross-border participation of foreign capacity resources to national CRMs is the only and realistic option for the integration of European CRMs. Chapter 4, then, analysed the question of why the integration of CRMs is a necessity for the EU. It was explored and justified that both economic and legal reasons oblige EU Member States to integrate their national CRMs with neighbouring CRMs. First, from a legal perspective it was put forward that the relevant legal framework including TFEU, Electricity Directive and Security of Electricity Supply Directive permits Member States to establish CRMs in their jurisdictions with the aim of ensuring generation adequacy. Further, EU State Aid Rules make the integration of CRMs mandatory by law. That is, it was discussed that the Commission uses State Aid Rules as a policy instrument to harmonise State Aid policies implemented by Member States. For CRMs, the Commission practises this authority through the Guidelines on State Aid for Environmental Protection and Energy 2014-2020 (the Guidelines). To prove this argument, several decisions have been taken by the Commission regarding CRMs of several Member States. Within this framework, State Aid decisions of the UK, France, Germany and Greece were investigated and it was concluded that these decisions show in a practical sense how the Commission employs State Aid Rules to shape the generation adequacy policies of Member States. In addition to State Aid Rules, it was further explained that the EU legal framework concerning the Free Movement Goods (according to Articles 34, 35 and 30 of TFEU) have been used by the Commission to prevent Member States from designing their CRMs based on a unilateral approach.

The integration of European CRMs was also justified from an economic point of view in Chapter 4. Economic justifications for the integration of European CRMs were discussed in terms of reducing the general generation adequacy costs for Member States and avoiding the distortive effects of unilateral CRMs in adjacent electricity markets such as the EU electricity markets. At first, the electricity market structures of Member States with regards to reserve margins, stress events and generation mixes were revealed. These differences among Member States offer great opportunity to ensure generation adequacy at lower costs. In this sense, integrating European CRMs is a critical way of creating a synergy effect from these differences. Second, it was shown that the integration of European CRMs is a necessity to prevent the distortive effect of unilateral CRMs. As discussed in detail in Chapter 4, unilaterally established CRMs in highly interconnected electricity markets like the EU create several challenges ranging from short term (prices and trade) to long term (investment decisions). To avoid these distortive effects of unilateral CRMs, it was again concluded that the integration of CRMs is a necessity.

Subsequent to these discussions concerning the justifications for integration, four minimum regulatory requirements for the integration of European CRMs were put forward. These minimum regulatory requirements are as follow: (1) Harmonised Generation Adequacy Assessments; (2) Respecting Contracted Capacity Obligations; (3) Allocation of Interconnector Capacity; and (4) No Double Counting. These requirements were individually analysed to show how they contribute to the integration of European CRMs. At the end of the Chapter 4, the relationship between the EUS and CRMs was dealt with. It was put forward that the EUS is a highly crucial step for CRMs in the process of integration. Three main interaction points between the EUS and CRMs were defined as follow: (1) State Aid Sector Inquiry for CRMs; (2) Enacting Necessary Legislation; and (3) Improving institutional frameworks. These are the points that the EUS may contribute to integration of CRMs.

2. Original Contributions to the Knowledge

"Has the age of capacity markets only just begun?"[1]

When Craig Morris asked this question in 2013, debates concerning CRMs had really only just begun: How the Commission will approach these incentive mechanisms; how market actors will meet these new incentive mechanisms; how climate change targets will be affected; how much the cost of electricity supply will increase for end-use customers; whether CRMs are being established to support environmentally harmful power plants like coal-fired power plants; and how the unilaterally established CRMs of Member States will affect the functioning of the IEM were being considered and discussed among academicians, national and international institutions, and sectoral and professional organisations within the EU context. This thesis is an attempt to contribute to these discussions. Of course, it is a matter that goes beyond the scope of this thesis to answer all these difficult questions.

This thesis makes some main contributions to the literature:

1- This study puts forward an answer to the question of why energy-only markets may not be reliable to ensure generation adequacy. In doing this, this study puts forward a comprehensive literature review. It also reveals both classical approaches to this problem and contemporary developments that have exacerbated the problem. In the classical (or, in other words, old) studies on CRMs, the reasons for the establishment of these markets were generally based on the price mechanism that does not work. In Chapter 2 (Conceptual Framework), these reasons are analysed in detail. As discussed, unlike other markets, prices are not allowed to fluctuate freely in electricity markets

[1] MORRIS, C., 'Has the age of capacity markets only just begun?', Energy Transition The Global Energiewende, 29.05.2013, <https://energytransition.org/2013/05/the-age-of-capacity-markets/> accessed 10.03.2018.

due to different concerns such as market power abuse. This creates the missing money problem which has been the basic source of generation adequacy concerns in electricity markets. This problem alone was sufficient to explain the reason for the establishment of CRMs. However, as shown throughout this thesis, it is necessary to search for other reasons underlying the establishment of CRMs. Without doubt, this does not mean that the missing money problem is no longer a challenge. On the contrary, the missing money problem will continue to be a significant challenge until specific imperfections of electricity markets are overcome with the help of technological developments. It was understood that other reasons for the establishment of CRMs are usually the effects that increase the negative impact of the missing money problem. The most noteworthy of these reasons is the increase in intermittent RESs production. Indeed, it is no longer possible to examine CRMs without considering the RESs factor. Further, it is not difficult to predict that this factor will gain more importance in the relevant literature over the coming years. It is stated in the current literature, in both theoretical and practical studies, that there is a positive correlation between the establishment of CRMs and the increase in RESs production.

2- CRMs are currently one of the hot topics in the EU agenda. From supranational to national authorities and to many stakeholders, each relevant party is trying to analyse and solve challenges stemming from unilateral (national-only) CRMs. In this vein, this thesis makes a very timely contribution to these discussions. It provides a perspective for the current energy transition period, in particular for the European CRMs. So much so that CRMs are one of the most natural consequences of energy transitions in Europe. Increasing intermittency, failure of ETS scheme, increasing competitiveness of coal-power plants as well as other classical challenges have led to the establishment of European CRMs. Readers of this thesis can understand this transition within the context of CRMs. This transition is valid for both the EU and the entire world. It includes the increasing usage of smart-grids, shifting generation mixes towards low-carbon sources, improved environmental awareness and the growing importance of energy efficiency and demand side participation. In addition, it is noted that the geography where this transition is most felt is the European countries. In this regard, it can be said that CRMs have been inevitably born into the European Energy Transition. The reader of this thesis can easily understand the reason for the emergence of CRMs in MSs and its connection to the Energy Transitions. Naturally, it does not mean that this thesis answers all the questions. This is technically impossible. However, this thesis provides a fertile ground for future research.

3- This thesis puts forth the relationship between the Single Market (i.e. Internal Market) and unilaterally (national-only) established CRMs. While putting this issue forward, regulatory framework necessary to integrate the European CRMs is established. Some minimum regulatory requirements are defined that can enable capacity trading across borders within the EU. These minimum regulatory requirements are as follows: (1) Harmonized Generation Adequacy Assessments, (2) Respecting Contracted Capacity Obligations, (3) Allocation of Interconnectors' Capacity and (4) No double Counting Principle. As long as these requirements are met, capacity trading across borders in the EU can be achieved. Moreover, this thesis discusses that these regulatory requirements are not only valid to integrate European CRMs, but they can also be employed to integrate any two adjacent CRMs in any part of the world. So, this thesis reveals a solution for capacity trading between the UK and MSs, even the Brexit process will finish with 'no deal'.

4- Additionally, as stated in the Introduction chapter of the thesis, one of the main objectives of this study is to explore what kind of regulatory framework should be established to integrate European CRMs. Chapter 4, which is devoted to possible regulatory solutions to this problem, provides important contributions in many respects. First, it is revealed what CRMs mean in the context of European law and under what conditions these markets can be established. Subsequently, how the Commission has used State Aid Rules as a policy tool for Member States to act in compatible with its own energy policy is discussed. Actually, as shown in Chapter 4, Sadowska discussed the Commission's use of competition rules to achieve its regulatory objectives in her PhD thesis. This study adopted Sadowska's point of view and showed that the Commission also employed State Aid Rules as a policy tool to force Member States to establish their CRMs in accordance with European energy policy. As mentioned, seven State Aid Decisions taken by the Commission concerning CRMs were analysed to prove this approach. In this context, this approach could be seen as an important contribution to understanding the Commission's reaction concerning CRMs.

3. Recommendations for Further Research

3.1 Integration of demand side and alternative resources to the European CRMs

As indicated throughout this thesis, the EU electricity markets have undergone a substantial transition. CRMs have been an indivisible part of this transformation since the beginning of this decade. Some argue that CRMs seems to fit perfectly with this sea-change by filling the gap between environmental objectives and security of supply concerns.[2] In summary, CRMs are incentive mechanisms to attract new capacity investments and/or keep existing capacity sources online. In this sense, capacity resources are not only composed of supply side resources. Energy efficiency and demand side resources can also provide reliable capacity.[3] Within this context, the Commission indicated in its EUS Strategy that:

> "It is […] necessary to fundamentally rethink energy efficiency and treat it as an energy source in its own right, representing the value of energy saved. As part of the market design review, the Commission will ensure that energy efficiency and demand side response can compete on equal terms with generation capacity."[4]

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[2] BAUKNECHT D. et al, 'From Niche to Mainstream: The Evolution of Renewable Energy in the German Electricity Market' in SIOSHANSI F. (ed), Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches, Academic Press, 2013, pp.169-198; GONZALEZ-DIAZ F. E., `EU Policy on Capacity Mechanisms` in HANCHER L. et al (eds), Capacity Mechanisms in the EU Energy Market: Law, Policy and Economics, Oxford University Press, UK, 2015.

[3] European Commission, 'Consultation Paper on Generation Adequacy, Capacity Mechanisms and the Internal Market in Electricity', 15.11.2012, <https://ec.europa.eu/energy/sites/ener/files/documents/20130207_generation_adequacy_consultation_document.pdf> accessed 27.02.2018, p.1.

[4] European Commission, 'Energy Union Package: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank: A Framework Strategy for a Resilient Energy Union

It is known that CRMs have been more effective than energy-only markets to utilise demand side resources.[5] Therefore, all relevant actors in the EU have consistently and rightly highlighted the significance of the participation of demand side sources to CRMs under the same conditions with supply side resources. Demand side resources including demand response, energy efficiency and distributed energy deliver substantial values ranging from reliability (by providing fast and predictable resources for system operators) and environmental benefits (by displacing old and inefficient generation units) to economic advantages (by improving resource utilisation, displacing expensive generation units and deferring transmission investments) and customer savings (by reducing wholesale prices).[6]

In addition to demand side resources, energy storage technologies are also progressively becoming important in those electricity markets that are increasingly driven by intermittent electricity sources such as solar and wind power. In parallel with this fact, there are promising developments in storage technologies which are crucial to heal one of the most vital imperfections of electricity market, which is that electricity cannot economically stored. These storage technologies can be grouped as follows: large-scale pumped-storage hydro, flywheels, batteries, compressed air and electric vehicles.[7] Thus, CRMs can be used to incentivise energy storage technologies by accepting them as reliable capacity resources.

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with Forward-Looking Climate Change Policy`, Brussels, 25.02.2015, COM(2015) 80 final, <http://eur-lex.europa.eu/resource.html?uri=cellar:1bd46c90-bdd4-11e4-bbe1-01aa75ed71a1.0001.03/DOC_1&format=PDF> <https://ec.europa.eu/energy/sites/ener/files/publication/FOR%20WEB%20energyunion_with%20_annex_en.pdf> accessed 26.02.2018, p.12.

5 IEA, 'Re-powering Markets Market design and regulation during the transition to low-carbon power systems', Electricity Market Series, OECD/IEA, Paris, 2016, <https://www.iea.org/publications/freepublications/publication/REPOWERINGMARKETS.pdf>, accessed 26.02.2018, p.160.

6 WINKLER E., 'Demand Resources in ISO-NE Markets and Planning', 27.10.2016, <http://www.ct.gov/deep/lib/deep/energy/ces/Demand_Resources_in_ISO_New_England_Markets_and_Planning_10-27-16.pdf> accessed 10.03.2018, p.7.

7 US Department of Energy, 'Grid Energy Storage', December 2013, <https://www.energy.gov/sites/prod/files/2014/09/f18/Grid%20Energy%20Storage%20December%202013.pdf> accessed 17.01.2018, p.4.

In light of the discussions above, further research can and should be made about how to integrate demand side and alternative capacity resources to the European CRMs. As indicated in this thesis, including participating demand side resources and storage technologies to CRMs in EU Member States is theoretically possible. However, it should be tested to what extent European CRMs could be successful in attracting demand side and alternative capacity resources. In this sense, the UK capacity auctions held over the last three years should be paid particularly close attention. Furthermore, experiences in PJM and New England electricity markets should be analysed to explore how they incentivise these resources through their CRMs. Finally, the research may propose regulatory solutions to increase the attractiveness of European CRMs for demand side and alternative capacity resources.

3.2 The Situation of Thermal Power Plants in Energy Transitions and the Role of CRMs in This Process

As mentioned throughout this thesis, the operating hours of thermal power plants such as natural gas and coal power plants have dropped dramatically due to the transition in electricity markets which has led to the rapid increase of electricity from intermittent RESs. The profitability of thermal power plants, which have already had profitability problems because of the classic missing money problem, decreased even further due to these reasons. However, as discussed previously, thermal power plants, especially natural gas power plants, are emerging as a strategic element of the Energy Transition process with their capability to provide flexibility. For this reason, the profitability of natural gas and coal power plants has become an important issue that cannot be left to market mechanisms.

With the above understanding, there is a need to study the changing business models and financial structures of natural gas and coal power plants and their changing functions in electricity markets in the process of energy transition. It is true that there is already a growing body of literature in this regard. As a contribution to the growing literature in this sense, studies dealing with the role of CRMs for natural gas and coal power plants will be important. The reason for this is that it seems that CRMs will inevitably play a critical role to attract new thermal power plant investments and/or keep the existing thermal power plants online. In this sense, the relationship between climate change targets and CRMs will continue to be a hot topic. Also, looking for an answer to the question of whether CRMs will only be a bridge in the ongoing energy transition or whether they will be an inseparable part of the changing structure of electricity markets is an attractive problem for researchers working on this issue.

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